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ABSTRACT

Provided are course materials designed to acquaint people who are preparing to build their own homes with some basic ideas for planning and constructing an energy efficient residence. The manual's 11 sections address such topics as the site, structural systems, finish materials, and construction. Each section contains overview statements on major concepts and approaches covered, student handouts, task analysis sheets, and suggested references. To teach the course, an instructor should have experience and education in the building construction field. (Author/WB)

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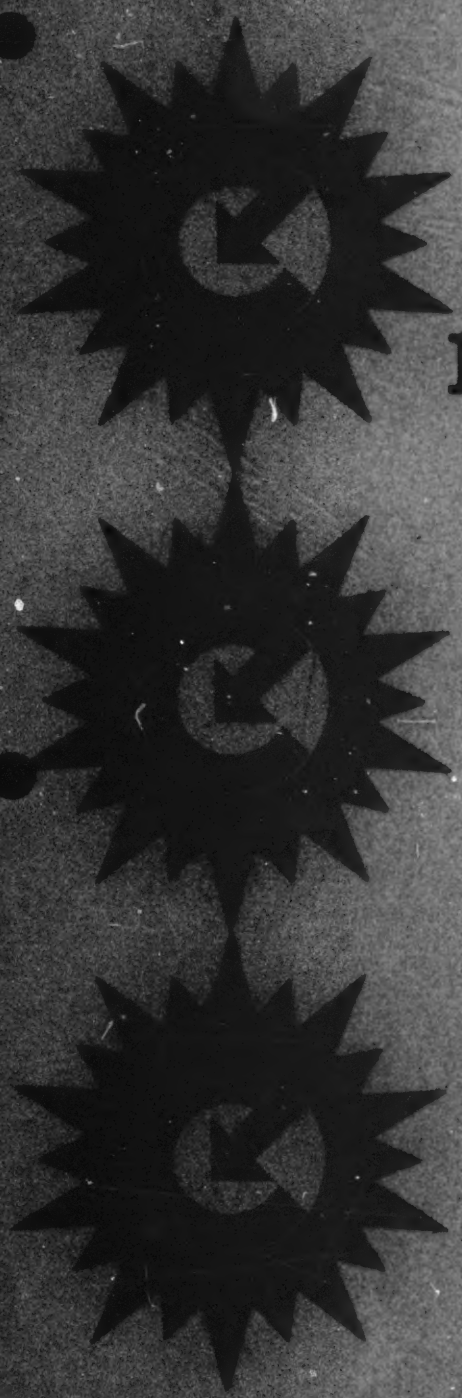

Building An Energy Efficient Home

Course Outline and Instructional Materials

Program Development
Dept. of Community Colleges
Raleigh, N.C. 27611

SE 034 416

BUILDING AN ENERGY EFFICIENT HOME

Course Outline and
Instructional Materials

June 1979

Compiled and Written by

Dail Dixon and Mary Dilday

for

Energy Conservation Curriculum and Short Course Project #8808
Program Development Section, North Carolina Dept. of Community Colleges

Project Director
Roger G. Worthington

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Frank Gourley, Jr.

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FOREWORD

This instructional manual was prepared by the Department of Community Colleges as a part of its plan to provide courses on energy conservation which reflect the adult education and community service needs of the population of North Carolina. The manual is intended to meet those needs in the specific area of home design and construction. The material was designed to teach potential owner-builders the principles of constructing an economical energy efficient residence. It is our hope that the ideas in this manual will aid individuals in viewing the energy crisis as a challenge to which there are viable and attractive solutions.

Roger G. Worthington, Director
Program Development Section
Department of Community Colleges

Charles R. Holloman
Senior Vice President in Charge
Department of Community Colleges

PREFACE

The purpose of this course is to provide those who are preparing to build their own homes with some basic tools for planning and constructing a dwelling. Instructional materials for the course have been divided into eleven major topics: overview, planning, site, authorities, structural systems, finish materials, environmental systems, getting ready to build, construction and summary. Depending on the time available and the emphasis desired, other topics can be included or existing sections can be expanded. The construction section, for example, can easily be expanded to four sessions or more depending on the time available.

The instructional materials provided are designed to reduce the preparation time required to teach the course. It is preferable that the instructor chosen to teach the course has experience and education in the construction field. A review of the instructional materials and suggested references should provide the necessary orientation to respond to the variety of interests individuals taking the course will have.

A course outline is provided. The instructional materials include overview statements on major concepts to be covered and energy efficient approaches to be considered. Also included are handouts, task analysis sheets and suggested references by topic. In addition, a set of 35mm slides is available to each institution to assist in teaching the course.

The instructor is encouraged to adapt this material to the particular needs and interests of the class, supplementing with additional materials, field trips, experience of class members, and outside resource people where possible. The course should provide information that will help individuals build houses that reflect a respect for the environment and conserve energy and materials.

Frank A. Gourley, Jr.
Project Coordinator

ACKNOWLEDGEMENTS

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GENERAL INFORMATION

Course Description

Building an Energy Efficient Home is a practical course for the owner-builder. This course is directed at methods and activities the owner-builder can use to erect a safe, energy-efficient dwelling. Identifying personal needs, planning energy efficient systems, diagraming, terminology, selecting materials, and construction skills are some of the main activities.

Basic Course Overview

Planning

The owner-builder will want to be involved with identifying the requirements of the dwelling, with budgeting time and money advantageously, and with learning how to organize structural spaces into a responsive dwelling. The individual will want to understand enough about mechanical systems to choose those which will work best for various dwellings and lifestyles.

Design

The owner-builder will want to learn to be aware of the influences of site characteristics and social and economic factors. Designing a dwelling is a planning and doing experience that should be enjoyed. Emphasis should be placed on designing for energy savings (such as possible solar designs, trombe walls, 6" insulation in walls, double glazed windows, etc.), low maintenance costs, and use of recycled materials (i.e., windows, doors, fixtures . . .). The first step in house designing on paper should be bubble diagraming. This will determine space priorities, locations, house orientation and traffic flow throughout the house. Individuals should research the effect their local building codes may have on the design of a house and what literature is available in working with the code.

Construction

The owner-builder will want to develop some skills related to construction decisions, such as effects of construction decisions on energy conservation, knowledge of material characteristics, and calculating the amounts and costs of materials needed. Subcontracting capabilities should be covered in the task work, but individuals may want to do their own work whenever possible. Encourage students to put the best possible quality into their workmanship. Individuals may want to look for local help if they need it. They can ask friends. If they can afford to hire labor, they can look for help from local high schools and college students--if the individual knows what he/she wants done and can show them.

Students will want to be encouraged to use their own ideas in planning, design and construction. If there are any problems (structural, systems or otherwise) refer them to an expert.

OVERVIEW

OVERVIEW

The purpose of this course is to provide those who are preparing to build their own homes with some basic information and skill for planning and constructing a dwelling. The course should develop personal philosophies about building that are based on respect for the environment and conservation of energy and materials.

This course is divided into suggested areas of planning, designing and actual construction calculations and techniques. Activities are provided in each of these areas as well as handouts where technical information may be needed.

This overview to the course includes a slide presentation with a narrative. This presentation covers briefly the important concepts on which this course is based. It should prompt discussion about topics of primary concern to the students. (Slides are present only in instructor's copies of course.)

The Course Outline (Handout #1) and the Bibliography (Handout #2) will be important parts of the overview. Students should have a local source for books listed in the Bibliography.

In the first class session(s) students should assess their own self-determination before starting such a massive project. Every student should know his/her limitations in terms of time, money and motivation.

The time one spends in planning may be directly proportional to the quality of the finished product. Students should be assisted in assessing their abilities to carry the project through to the end. Building a house can take from several months to several years. Students need to realize that building a house will probably mean dropping a lot of other activities and spending less time with family. The stress of making the number of decisions required, attending to the necessary details, and actual involvement in doing new things should be pointed out.

Money is of primary concern; building and owning a house is a big investment. Planning ahead can cut costs. Encourage trying to avoid long-time indebtedness. Drawing from savings, building with money earned as you go along, and recycling materials are several ways to cut costs and lower possible finance charges. This is the time for students to start investigating finance possibilities; they should start shopping around for financial resources. By doing this they will discover limitations institutions put on money loaned and who has the best interest rates. Lending institutions may require insurance. The Real Estate Settlement Procedures Act (RESPA) should be discussed.

Motivation is an important factor. Students should be encouraged to be honest with themselves about why they want to build. Students should be assisted in identifying their real needs in a house.

Narrative for Slide Presentation

The intent of the slide presentation is to present to the students a series of owner and contractor built energy conserving houses as an introduction to possibilities for themselves.

1 Title slide.

2 Credit slide.

3-4 This fanciful house, still in construction, is the product of one man's work for approximately three years. He has a personal vision of his house and it is growing organically.

5-6 This is a different vision of a "dream house." The owner acted as manager of this in-town house, effecting a significant savings over contract price. It is basically an "Arkansas House" that has 6" walls with 6" batt insulation, 6" batts under floor, R-30 in attic space and a heat pump. In addition, the majority of the glass is located on the south side for solar gain advantages.

7-8 An owner-built geodesic dome. This idea is appealing as it maximizes interior cubage for exterior perimeter, lowering materials costs and heating costs. The large south window provides most of the daytime heat on sunny winter days.

9-10 This ambitious family bought an old gambrel dairy barn and moved the roof to a new site, building a new first floor under it. They were able to occupy the first floor after working nights and weekends for 15 months. Work on the upstairs is in process on a pay-as-you-go basis.

11-14 This is an owner-managed house with several interesting energy ideas. The house is built around a solar atrium which collects heat for the house in the winter. Note the solar collectors for heating water mounted at the peak of the acrylic roof that covers the central atrium. In summer the extra heat generated under the acrylic roof increases the "chimney effect" and amplifies ventilation through the house by drawing hot air up and out through windows at the top of the walls of the atrium. Slide 13 shows the solar hot water system with well-insulated tank and pipes. Slide 14 shows fresh air inlets to provide combustion air for fireplace.

15-18 This one bedroom owner-managed house has a passive collector wall on the south side. As the sun heats the collector, air is drawn into the collector from near the floor, heated and re-enters the house near the ceiling. Note arrow indicating vents at top and bottom of wall. The living room floor is treated concrete, which is both attractive and functional as thermal mass storage for the south glass.

19-21 This owner-builder bought his house for the price of the land only. Five years of effort have saved the structure at a significant savings over new construction costs. One surprise was the discovery of a hand-hewn log cabin which has been used as a decorative wall in the living room. The floors are original heart pine--a real asset in renovation work. A wood stove in the living room provides supplemental heat.

22-24 This owner-builder built his house around a massive stove chimney with flues for a wood hot water heater, a fireplace, a wood stove (which heats the house) and a hibachi for cooking. The south side is waiting for a thermosyphoning air collector which will augment wood heat on sunny days, during the winter. The site includes the advantage of deciduous trees that provide shade in the summer but lose their leaves in winter to allow the sunlight to strike the future thermosyphoning air collector.

25-26 This owner-managed house was built for approximately 60% of established square foot price by careful budgeting and materials selection. The solar furnace (collector, controls & storage) is built at south edge of woods. Interior view illustrates comfortable atmosphere created by use of natural materials and comtemporary furnishings.

27 The owners of this house managed construction and did much of the trim work, cutting the cost of the work by 25 percent. It is an "Arkansas" type house with glass concentrated on the south side.

28-29 A Finnish family is building this sod roof house on a lot thought unbuildable because of its relationship to a busy road. By burying the north (road side), they have excluded noise and view of the road. The entire south side is glass. Concrete slab with quarry tile covered floor will provide thermal mass. Note "Keep Off Grass" sign.

30 This owner-built structure started as a relocated log tobacco barn. The rock chimney was built by a nurse with previous construction experience.

31 This small multipurpose, unheated workshop was built by the same builder as the structure in slide 30 for less than $1500 by using all green rough cut pine.

32-33 This house is being built by a retired man and his family after living in 27 leased or rented houses. It will have solar air collectors and a heat pump for heating. The house is built as three separate units and surrounds a courtyard which will be intensively landscaped to contrast with the fifteen acres of wilderness which surround the house.

34-35 This house is truly a hand crafted project. The owners have built everything, including the furniture, with care and love.

36-37 This interesting house was designed by Ken Kern and is being owner-built. It is on 8 x 8 salt treated poles and steps down the hill. It has many beautiful owner-builder touches. Even though on a very limited budget, the owners opted to buy expensive top line wood casement windows. The house is heated with a wood stove.

38-39 This is a new (as opposed to recycled) log cabin, a very labor-intensive project that beautifully fits its site.

40-41 This owner-built project has external insulating shutters on the south side. They can be folded up by a pulley system under the eaves. The "Dutch" door is 4" thick and has 3½" of insulation inside. Weather-stripping around the door keeps it airtight when closed.

The next segment of slides in this series represents interesting energy utilization ideas.

42-45 This house has an active solar air collector system. The attic, with its translucent cover and black walls, (not painted yet in Slide 43), collects heat which is moved into storage (rock) or into the house by a complicated electronic network. The domestic solar hot water collector is shown mounted in the attic space. The house also has rectangular, shuttered skylights which admit sunlight directly into the living spaces. The outside vents below the roof peaks connect to the collector volume and to the living spaces for summer ventilation.

46-47 This house has three solar ideas at work: flat plate collectors for domestic hot water, a passive solar greenhouse, and a passive collector wall similar to the one in slides 15-18 except that it has glass as a cover over the collector wall.

48-49 This is an energy intensive passive house. Its solar heat collection is by a two-story solar greenhouse. The house is buried on the north slope and the retaining wall becomes a thermal mass storage system. In addition, it has a vertical passive collector wall shown in black next to the greenhouse.

50 This owner-managed house has a south facing greenhouse designed as an integral part of the residence. Hot air from the greenhouse is drawn through ducts to other parts of the house for heating in the winter. The rectangular cupola helps create a stack effect for cooling in summer. By opening the cupola windows and the downstairs windows, hot air is drawn up and out through the cupola windows.

51-53 This expensive intown house employs its enclosed swimming pool as a heat sink for a winter source heat pump. The collectors heat the pool water, providing a $\pm 75^{0}$ winter temperature for the heat pump, which is predicted to provide the equivalent of 3 to 3-1/2 kilowatt hours of heat for every kilowatt of power purchased.

54 Case House: This group of slides illustrates the process of construction on a house very similar to the "Case House" which is used for the student handouts in the course. The slides should form the basis for a review of the major points covered in the course material and class discussion.

55 Block foundation partially complete. Batter boards in background. Note L-shaped blocks to catch concrete slab to be poured after fill is complete. Large fill required on left at some extra expense.

56 Foundation and batter boards. Note conservation of trees on site.

57 Block foundation ready for slab, with rock fill, rigid foam insulation, insulation vapor barrier, welded wire mesh, plumbing, and wiring in place. Greenhouse area to left also ready for slab. Area to right will use floor joists.

58 Pouring concrete slab.

59 Smoothing concrete slab.

60 Framing (2" x 6") with temporary bracing. Headers have insulation in voids and corners are preinsulated. Note this area of house uses floor joists with crawl space and therefore needs venting.

61 View of insulation between floor joists held in place with chicken wire and tiger teeth.

62 Framing near completion.

63 Roof framing going up with plywood bracing on corners.

64 Roof framing detail. Shed roof allows addition of loft not included in course handouts on Case house plans.

65 Large framing spans in south facing exterior wall for glass in greenhouse area.

66 House dried in. All sheathing and windows hung. All windows are double glazed.

67 View of chimney and masonry wall filled with sand designed to be used as thermal mass to store radiant heat from wood stove and, to a lesser extent, heat from the adjacent greenhouse.

68 Inside view looking out into greenhouse taking shape.

69 Outside view of greenhouse showing how roof of house and greenhouse are integrated.

70 Detail of roof/greenhouse interface prior to glazing and roofing. Wood cant and aluminum extrusion installed with aluminum flashing partially installed.

71 Example of wall insulation with vapor barrier.

72 Example of insulated ducts. Round duct is insulated on the outside and square duct is pre-insulated on inside.

73 Pressure-treated pine siding being applied.

74 Application of pressure-treated pine siding almost complete.

75 House approaching completion. View of greenhouse with double glazed glass as barrier to heat loss. Note aluminum roof vents to vent air into roof over roof insulation. These vents are needed since there is no other way to get air movement in the roof air space.

76 Interior view of sandfilled masonry wall with stucco applied and quarry tiled floor. Because of energy efficient design features, house can be heated by the wood stove shown.

77 Entrance foyer with salvaged doors.

15

78 House completed.

79 Acknowledgements.

The slides in this series should be used periodically through the course for reference and can be rescreened during the summary session. They illustrate that people's big ideas do get built, can be energy conscious and are often beautiful.

HANDOUT #1

BUILDING AN ENERGY EFFICIENT HOME

Course Outline

I. Overview

Goal: Illustrate successful projects, approaches with slide presentation, orientation to course method and materials.

A. Course Description

1. Planning
2. Design
3. Construction

B. Introduction

1. Purpose
2. Motivation
3. Time
4. Money

C. Slide Presentation

Handouts: #1, Course Outline
#2, Bibliography

Task Analysis Sheet #1

II. Planning

Goal: Outline necessary decisions required for house planning.

A. Budget

1. Time/Money
2. Motivation
3. Front End, Life Cycle, Operational Costs
4. Renovation

B. Architectural Space

C. Basic Environmental Systems

1. Conventional
2. Non-conventional
   a. Wood
   b. Solar
      (1) Energy Efficient Construction
      (2) Passive Solar Construction
      (3) Active Solar Construction

D. House Size and Layout

E. House Planning Form Narrative

Handouts: #3, House Planning Form
#4, House Planning Form - Case House
#5, Your Next House

Task Analysis Sheets #2-#8

III. Site

Goal: Familiarize student with information and decisions required in site selection.

A. Macro Site

1. Zoning
2. Road Access
3. Utilities
4. Drainage
5. Neighbors
   a. People (Structures)
   b. Uses
      (1) Allowed
      (2) Existing
6. Noise
7. Views
8. Breezes

B. Micro Site

1. Deed Restrictions, Covenants
2. Sun Orientation
3. Drainage
4. Views
5. Vegetation
6. Driveways
7. Utilities

Handouts: #6, Site Planning Form
#7, Site Planning Form - Case House
#8, Plot Plan - Case House
#9, Site Analysis - Case House
#10, Preliminary Site Design - Case House

Task Analysis Sheets #9-#11

IV. Authorities/Bubble Diagraming (Site Relationships)

Goals: Twofold: a) Familiarize students with authorities who have legal jurisdiction over their plans and others who may help or add their input to design process; b) Develop design methodology for house design.

Part I

A. Authorities (legally having jurisdiction)

1. Codes
   a. N.C. Residential Code
   b. Local Codes
   c. Health Department
   d. National Electrical Code

2. Inspectors

B. Authorities (having subtle control)

1. Lending Agents
2. Developers

C. Authorities (who may be helpful)

1. Architects
2. Engineers
3. Tradesmen
4. Material dealers

Part II

Bubble Diagraming

1. Tools Required
2. Why Bubbles
3. Site Relationships
   a. Room Requirements
      (1) Function
      (2) Light
      (3) Views
      (4) Access
      (5) Privacy
      (6) Energy
   b. Simultaneous Development of Program of Spaces

Handouts: #11, Bubble Diagram (Site Relationships) - Case House
#12, Offer to Purchase and Contract
#13, Sample Building Permit Application

Task Analysis Sheet #12

V. Structural Systems/Bubble Diagraming (Room Relationships)

Goals: a) Provide basic knowledge of structural concepts and rule of thumb information and possibilities of various materials and systems; b) Refine bubble diagraming to include circulation and room relationships.

Part I

A. Basic Structural Design

1. Floor Systems
   a. Slab on Grade
   b. Wood Frame
2. Wall Systems
   a. Post and Beam
   b. Bearing Wall
3. Roof Systems
   a. Rafters
   b. Trusses
4. Domes

B. Basic Structural Materials

1. Concrete
2. Wood
3. Masonry
4. Plywood
5. Fasteners

Part II

Bubble Diagraming (Room/Area Relationships)

1. Public Areas
2. Private Areas
3. Service Areas
4. Circulation Spaces

Handouts: #14, Bubble Diagram (Spatial Relationships) - Case House
#15, Bubble Diagram (Room Relationships) - Case House
#16, Preliminary Structural Design - Case House

Task Analysis Sheets #13-#15

VI. Finish Materials

Goal: Familiarize students with options available in finish materials and cost and relative energy efficiency.

A. Exterior Materials

1. Foundation Walls
2. Siding
3. Roofing

B. Interior Materials

1. Floors
2. Walls
3. Ceilings

20

Handout: #17, Finishes - Case House

Task Analysis Sheets #16-#21

VII. Environmental Control Systems

Goals: a) Develop basics outlined in planning; b) Familiarize students with information and ideas associated with various approaches to assist them in decision making.

A. Checklist Review of Planning/Design of Basics for Heating Systems

1. Forced Air Systems
2. Radiant
3. Wood Heat
4. Passive Systems

B. Natural Cooling

1. Shading
2. Ventilation
   a. House
   b. Attic

C. Plumbing System

D. Electrical System

E. Renovation

1. Plumbing
2. Electrical
3. Mechanical

Handouts: #18, Heating and Ventilation - Case House
#19, Electrical Plan - Case House
#20, Heat Loss Calculation Form A
#21, Heat Loss Calculation Form B
#22, Heat Loss Calculation - Case House

Task Analysis Sheets #22-#24

VIII. Getting Ready to Build

Goal: Review items necessary to actually begin construction including application for permits and financing.

A. Materials Lists

B. Financing

C. Subcontractor Contracts

D. Siting

E. Insurance

F. Motivation

G. Tools

H. Permits

I. Job Record Keeping

Handouts: #23, Description of Materials: USDA-FHA Dwelling Specification
#24, Sample Materials Estimate Form - Carolina Builders Materials List
#25, Cumulative Job Cost Record Sheet

Task Analysis Sheet #25

IX. Construction

Goal: Proceed through an orderly approach to the construction process exposing the student to ideas, techniques and potential problems along the way. Material for four sessions listed in chronological order, breaks to be determined by class need.

A. Foundations/Beginning

1. Footings
2. Foundation Walls
3. Insect Control

B. Drying In

1. Floors
2. Walls
3. Roof
4. Insulation Systems
5. Sheathing
6. Windows
7. Doors

C. Installing Environmental Systems

1. Duct Systems
2. Wiring
3. Plumbing
4. Solar Hot Water
5. Insulation

D. Finish Work

Task Analysis Sheets #26-#28

X. Summary

Goal: Summarize previous class material and address questions. Class discussion of individual solutions.

A. Summary

B. Rescreening of Slide Presentation and Noting of Particular Systems

1. Success
2. Failures

C. Review Outline and Bibliography

D. Discuss Individual Student Solutions

HANDOUT #2

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ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: OVERVIEW

TASK: (No. 1) LIST REASONS FOR BUILDING (SUBJECTIVE TASK)

COMPETENCY: TO CLEARLY STATE PRIMARY REASONS FOR BUILDING AND TO UNDERSTAND THE NEEDS OF THE PEOPLE WHO WILL LIVE IN THE DWELLING

CRITERION MEASURE:
DEFINES PERSONAL REASONS FOR BUILDING
DEFINES THE TYPE OF PEOPLE WHO WILL OCCUPY HOUSE
DETERMINES IF MOTIVATION IS HIGH ENOUGH FOR EXTENDED PROJECT

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Define reasons for building	I. What are personal reasons for building? A. Personal or family need B. Dissatisfied with standard dwellings 1. Waste valuable energy 2. Do not fit lifestyle 3. Physically uncomfortable C. Personal interest? 1. Personally involved with construction work 2. A challenge	I. Understand personal motivation
II. Define type of people who will occupy house	II. Personal Characteristics A. Number and type of people 1. Family 2. Couple 3. Individual B. Needs of each individual 1. Type of lifestyle 2. Need for privacy 3. Compatibility with other dwelling members 4. Physical needs (sleep, food, etc.)	II. Understand <u>who</u> building is for

REFERENCES (see Bibliography for complete information)

Major References

From the Ground Up is a well written and beautifully illustrated source for the entire planning/designing/building process. This probably is the best all-around text for the course. It is based largely on work at Maine's Shelter Institute. Its approach is toward energy efficient, labor intensive owner building.

The Solar Home Book is the basic solar text. It is prejudiced toward passive approaches but describes active systems as well. Included are formulas and data required for calculating solar heating systems.

Your Energy Efficient House is another basic text for the energy efficient owner builder. Ideas are presented with many sketches which will be very helpful to the student.

Other Helpful References:

The Owner Built Home is an excellent guide for anyone who intends to provide a majority of the labor to build his/her house. Ken Kern's approach is labor intensive. Students should be advised to consider them in that light and not attempt to contract with others for this kind of construction.

Low Cost Energy Efficient Shelter is an anthology of articles on many specific areas of energy efficient design and construction.

30 Energy Efficient Houses includes sections on design and construction and has photos and plans of houses completed. It is an excellent idea book particularly for low cash projects.

All references here would be helpful in preparing to teach the course. The three major references should be required reading for instructor and students.

PLANNING

PLANNING

This section should once again challenge the student to come to grips with real housing needs and his/her motivation. It includes discussion of budget, architectural space, and basic information about choices for heating systems. Included as a handout is Your Next Home by Giles Blunden and Lucy Davis, which will help students understand the implications of various configurations and insulation systems.

Budget

Budget is perhaps the main consideration of most owner-builders. The student should be made aware of two particular types of considerations. The first is the balance between time and money. The more time spent in personal endeavors (planning, designing and actual construction), the less the dollar cost will be. Building one's own house is going to require a large amount of personal effort. Physical and psychic energy even at the lowest level of involvement should be emphasized.

The second consideration is cost, not just the cost of actual construction, but the maintenance costs over time (servicing and replacing parts), costs of energy to operate systems, environmental costs (does it use renewable resources? does it pollute?) and social costs (does it make you dependent on someone else to supply your energy needs?). These should all be discussed. The student should learn to recognize that materials that are low in cost and/or fast and easy to install and/or simple to operate may not always be the best choice for his/her dwelling. Choosing inexpensive materials may result in frequent replacing or servicing.

It is imperative that the student be given information and resources necessary to determine the best ways to balance his/her interest and ability to borrow, pay, or provide time on the project and the relative value of those options. Much of this information is specific to your region and must be attained from local sources.

Obtaining financing for construction may well be the most difficult part of the owner-built housing process. Lending procedures and practices vary, and students should be encouraged early in the process to approach various banks. Local contractors should be asked for a range of square foot costs for their work. In addition, they may be helpful in breaking down costs for management, materials, labor, and various subcontractors. It is important for the student to have a feel for these relationships so that he/she can consider what options are available for trading time for money. Architects, subcontractors, materials suppliers, bankers, real estate brokers may also be able to help establish cost rules of thumb.

It is important to emphasize that many owner-built houses are never finished. The process of building one's own house is a demanding one which shouldn't be taken on without careful consideration of the sacrifices that will have to be made.

One interesting approach for owner/builders is renovation. Houses are often much depressed in value because house buyers are turned off by a rotten bathroom floor, a small kitchen, or termite damage. One of the houses in the

slide survey was given no value in a land sale because of termite problems and was completely renovated for $12.00 per square foot.

Advantages of renovation are the acquisition of inexpensive space and a chance to preserve an old house which might otherwise be lost. It is difficult, however, to establish a budget for renovation cost. Renovation work necessary to bring old houses up to today's standards can be deceptive. Also to be considered is the challenge of redesigning the existing structure into a living space which meets the needs of today's owner; for instance, many families now enjoy open space instead of the more traditional, formal room arrangement of older houses.

Architectural Space

A great majority of the course material will deal with quantitative assessments of space, materials, systems, etc. This section deals with the qualities of architectural space and how they affect the design of houses. Class discussion should develop ideas about architectural space which probably will be a new idea for students. It will be useful to develop a list of words which describe spaces (cozy, warm, rich, light, dark, etc.), the things that make spaces have those qualities and the types of rooms for which those qualities might be appropriate. There should be a discussion about the qualities of natural light, e.g., east light is very different in its effect on a room than is west light. Students should be encouraged to think about ceiling heights, room shape, texture, views into and out of rooms, etc. The discussion should include energy implications of these choices. In terms of thermal mass possibilities, south light and air circulation, The Hidden Dimension by Edward Hall is a fascinating reference which deals with conversation distances, personal distances, etc., which affect the way people use rooms.

Environmental Systems (Basic)

A well-insulated, energy-efficient house in Piedmont, North Carolina may have a heat loss of 20 BTUs per square foot per hour when it is 10° outside and 70° inside and could cost as much as $100 to heat in January.

Basic to planning any energy efficient house is a way to provide a comfortable environment for the inhabitants in a way that is gentle to the pocketbook and the earth's diminishing fossil fuels. This section outlines major types of heating and cooling systems in an attempt to give the students a basis for thinking about options while beginning to design their homes.

Conventional Systems

Conventional heating systems are powered by conventional fuel resources: electricity (generated by coal, oil, sometimes hydroelectric), oil, coal, natural gas, propane gas, methane. All (with the exception of hydroelectric and methane) are non-renewable. The most pessimistic studies anticipate oil resources will be depleted in the late 20th century, long before the houses the class is considering will be ready for demolition. It makes sense to plan for systems which rely as little as possible on these conventional systems which, even given continuing supplies, will become rapidly prohibitive to operate.

Conventional systems can be broken down into two basic groups, ducted (forced air) and radiant. Forced air systems employ fans which circulate conditioned air through a heating unit and into the house. These systems have the advantage of the ability to circulate hot air which may be created near a wood stove or solar greenhouse/wall throughout the house. In addition, a forced air system offers the designer the opportunity to add humidification and air filtration into the system.

Radiant (baseboard or radiant slab) systems rely on convection into occupied space from either hot water or electric resistance wire. These systems generally offer more control of individual room temperature by virtue of individual thermostats. They are generally quieter and do not add air circulation (drafts) into the house. The low front end cost of electrical baseboard often makes it an excellent choice for backup in an intensive solar heated house. Radiant slabs, while relatively expensive, have many built-in economies, particularly when used in conjunction with solar heating as the water temperature for heat (±90°) falls well within capabilities of flat plate collectors.

Non-Conventional Systems

Wood Heat

Wood heat represents an interesting alternative for primary or back-up heating systems in relatively rural or wooded areas. Wood is a renewable resource and, given the multiplicity of available energy sources in our region (electric, gas, oil, and solar) is not likely to be overused.

Choices for heating appliances range from inefficient fireplaces which have almost no practical heating value to very high efficiency stoves and furnaces. Using figures taken from a Popular Science, February 1978 article, "Wood as Fuel," a cord of wood will produce from 2.3 to 13.8 million BTUs of heat which has an equivalent value when compared to 4¢ per kilowatt hour electric rates of $27.00 to $161.00. Compared to a value of ±$60.00 per cord, the more efficient stoves and furnaces are clearly a good heating bargain.

Advantages to wood heat are low cost and independence from conventional energy delivery systems. While wood heat does use a renewable energy resource, wood stoves must be filled and cleaned. Wood stoves should be centrally located and if possible indirectly connected to an air circulation system which can even out temperatures through the house. Wood storage areas need careful thought if wood heat is to be used.

Solar

Capturing the ±420 BTU/square foot/day of free solar radiation which is falling on the earth can enable us to live in houses relatively free of external energy sources. Solar energy in house construction can be considered on many levels ranging from very simple insulation and orientation ideas to elaborate liquid or air collector and storage systems capable of providing 70-95 percent of heating needs. For the purpose of preliminary planning, the student should consider three basic approaches.

Energy Efficient Construction

These methods should lower energy costs 20-40 percent over minimum property standards. The major features of this approach are proper insulation (R19 walls and floor, R30 ceiling, double glazing for all windows), careful control of infiltration (caulking under plates, around windows, and weather stripping doors), and proper orientation of glass (majority of glass ±10 percent of floor area on south side where solar gain is possible). The advantages of this approach are lowering energy costs ±10-20 percent while only slightly increasing construction costs. The disadvantages are limitations placed on the site with the south glass provision.

Passive Solar Construction

Passive solar design has as its major criteria admitting sun into the house and providing thermal mass (concrete, masonry, rock or water, etc.) within the house to store excess heat available during the day (when the sun is shining), and radiate that heat back into the house during cloudy or night times. Features of this system include south facing glass up to 25 percent of floor area (allowing the sun to enter the house directly or into greenhouse collectors), movable insulation for protecting glass area from excessive heat loss at night, and thermal mass in the form of masonry, concrete, or water within the house volume to store excess heat. It is important to match thermal mass storage systems to south glass to prevent overheating. As a rule of thumb for every square foot of south glass there should be from 1 to 10 square feet of mass surface area. The 1:1 system would be for a trombe type wall almost directly in contact with south glazing; the 10:1 for storage not directly in sun's rays such as in a remote storage area. This approach can reasonably generate up to 80 percent of winter heating. However, over 60 percent heat generation is generally not economically feasible.

Advantages of the passive solar approach are minimizing system technology, lowering front end costs, and operating costs for maintenance. Disadvantages include higher construction costs than conventional systems and less control of internal air temperature than in active systems. Passive systems typically require more manual types of control which must be supplied by the owner.

Active Solar Construction

Active systems include relatively high technology methods of collecting solar heat with external collectors and transporting the heat with fluid or air to storage, then to the house. A system of this type is composed of remote external collectors, some type of storage medium (rock, water, change of state salts, etc.), and a control network to transport and exchange the heat in the collectors. A system of this type can contribute up to 90 percent of the household energy needs and requires less input for daily operation on the part of the user.

The advantages of active systems include better control of inside temperatures and heat storage capabilities. When set up and operating, the system is similar in operation to conventional heating systems. Another possible advantage is that tax incentives offered by the state more clearly recognize active systems as being deductible.

Disadvantages include high front end costs and maintenance of a high technology system.

House Planning Form Narrative

The purpose of a house planning form is to assist individuals in coming to grips with realistic budgeting and arriving at a square footage allowance with which to plan. Many items must be taken into account, beginning with the amount of time and money the student has available and the general cost of construction in the region. Things which make the specific house more or less expensive than typical construction should be considered in an attempt to establish the prevailing cost to more accurately reflect the projected cost of the student's house. Listed below are several areas which should be considered relative to establishing a budget construction price.

I. Site

- A. Slope of land
- B. Condition of soil for footings
- C. Length of driveway
- D. Cost of site utilities

II. House Shape

- A. How many corners
- B. How many roof shapes

III. Mechanical Heating Systems

- A. Conventional
- B. Non-conventional

IV. Finishes

- A. Exterior
  - 1. Siding
  - 2. Foundation walls
  - 3. Roofing
- B. Interior
  - 1. Walls
    - a) Sheet rock
    - b) Masonry
    - c) Wallpaper
  - 2. Floors
  - 3. Ceilings
  - 4. Millwork (built-ins)

V. Space

- A. Open plan
- B. Traditional
- C. Number and size of rooms
- D. High/low ceilings

VI. Labor Costs

The house and room programs require the student to list both needs and desires for his/her house in a form that is readily available to other household members. The participation of others who will be using the house during the planning phase is an important step toward establishing the communication required to successfully complete an owner built home.

HANDOUT #3

HOUSE PLANNING FORM

Basic square footage cost for the region _____

Labor/materials budget reductions
(List items of labor and materials which you intend to provide at no cost to the project in dollars per square foot)

Labor	Materials	
_____	_____	site clearing
_____	_____	rough grading and footings
_____	_____	foundations
_____	_____	masonry
_____	_____	rough carpentry
_____	_____	siding
_____	_____	decks or patios
_____	_____	rough in wiring
_____	_____	rough in plumbing
_____	_____	rough in duct system
_____	_____	insulation
_____	_____	interior walls and ceilings
_____	_____	interior trim
_____	_____	cabinetry
_____	_____	trim wiring
_____	_____	trim plumbing
_____	_____	trim heating
_____	_____	painting
_____	_____	floor finishing
_____	_____	exterior landscaping
_____	_____	management
_____	_____	Other
_____	_____	
_____	_____	
_____	_____	

Total all labor _____
Total all materials _____
Subtract from basic sq. ft. costs _____

Economic factors: Class discussion will key on things which will make your house more or less expensive than the standard house.

Add or (subtract) $_____ sq. ft.
Total cost/sq. ft. $_____

Total dollar budget (exclusive of land costs) $_____
Your ability to borrow this amount should be verified with your lending institution.

$$\frac{\text{Total dollar budget}}{\text{cost per sq. ft.}} = \text{square footage estimate for house}$$

_____

The square footage budget must now be divided among the rooms which are part of your program. Before dividing the square footage subtract 15 percent for circulation space, closet space, and wall thickness.

House Adjectives

Pick the twenty words or phrases which best describe the house and list them in order of importance. (Have your spouse, or others who will be living in the house, do the same and compare.)

House Description

Write an article for a housing magazine which describes your house to a reader. Make reference to materials and shapes and energy ideas you would like to include.

Room Description

(Prepare a sheet for each room in the house and answer questions.)

Square footage budget _____
Preferred view direction _____
Preferred sun orientation _____
Relationship to other rooms
- open to _____
- next to _____
- down the hall from _____

Activities (list)
Furniture--specific sizes for pieces you will move; general sizes for intended purchases
Finishes
Lighting
Other requirements (telephone, plumbing, appliances, etc.)
Extend the article about the house to include a paragraph about each room.

ROOM DESCRIPTIONS

Case House

Living/Dining Room — 340 sq. ft.

View: to south
Sun orientation: south
Room relationships:
These two spaces are basically one perhaps divided by a fireplace. They will connect directly to the foyer and the dining space will be open partially to the kitchen.
Activities:
These are family rooms for a close family of 5. Most of family will be here most of waking at-home hours. Dining room will be used for all needs except weekday breakfasts and an occasional lunch. Entertaining is generally on a small scale.
Furniture:
Dining room: antique oak table, 3'-0" x 6'-0" with 6 chairs and oak china cabinet
Living room: existing love seat and two matching chairs, possibly add large lounge chair.
In addition this space will accommodate bookshelves and wall space for extensive art collection.
Finishes:
Walls and ceiling will be painted dry wall, floors dark brown quarry tile. Trim will be simple and painted.
Lighting:
Provide box for owner's dining room light fixture. Living room will have switched outlet for floor lamp.
High ceilings would be nice here and a large wood stove will be in this space.

Kitchen — 140 sq. ft.

View: south for solar gain, east light for breakfast nook
Room relationships:
Close to front door entry, close to dining room, and visually connected to dining room
Activities:
Normal kitchen activities, laundry and ironing
Lighting:
Fluorescent strip lighting over cabinets
Cabinets should be natural finish wood and very simple and inexpensive.
Appliances:
Refrigerator, drop-in electric range, washer, dryer, double sink, fan hood
Finishes similar to living room.

Foyer 50 sq. ft.

Relatively large space for entry, coat storage and some paintings
Orientation and view: not important
Room relationships:
Close visually to public areas of the house, close physically to private areas of house
Finishes:
Sheetrock painted
Include antique pair beaded glass entry doors

Large Bathroom 40 sq. ft.

View: Should be private, not absolutely necessary
Relationship to other rooms:
Accessible to children's bedrooms from hall and directly to master bedroom
Finishes:
Ceramic tile floor and shower surround. Otherwise, painted sheetrock
Lighting: Over lavatory
We will provide old 5' footed tub and pedestal sink for installation.

Half-bath 30 sq. ft.

Similar to large bath.

Master Bedroom 150 sq. ft.

View: to south for solar gain
to east for morning light
Relationship to other rooms:
Within the bedroom section of the house but as private as possible.
Activities:
No sitting area required. Small desk would be nice but not imperative.
Furniture:
Queen size bed, two upright dressers
Finishes: Oak floor, painted sheetrock
Lighting: One ceiling fixture

Second Bedroom 150 sq. ft.

View: Not critical
Relationship to other rooms:
Close to third bedroom and within bedroom section of the house
Activities:
This room is for twin girls and it is desirable to provide some level of privacy for sleeping areas. Desk area for quiet study is required.
Furniture:
Two twin beds; two dressers
Finishes: Oak floor, painted sheetrock
Lighting: One ceiling light

Third Bedroom — 100 sq. ft.

All items similar to bedroom #2 except it will be occupied by one child.

Small Play Area

View: Should be pleasant and south to daytime sun if possible
Relationship to other rooms:
Close to second and third bedrooms as far as possible from public area of the house.
Activities:
Children's group play area, piano, etc. This might be an alcove or such, not necessarily a room
Finishes: Oak floor, sheetrock
Lighting: One ceiling fixture

your next home

energy conserving design & construction

Compiled especially for the 1978 ENERGY FAIR sponsored by the Carrboro/Chapel Hill Independent Trades Group

THE INDEPENDENT TRADES GROUP WAS ORGANIZED TO PROMOTE AND ENCOURAGE THE DEVELOPMENT OF SMALL BUSINESSES IN THE CONSTRUCTION INDUSTRY IN AND ABOUT CHAPEL HILL. THROUGH INDIVIDUAL REPUTATIONS, SEMINARS, WORKSHOPS AND PROJECTS, IT ALSO HOPES TO EDUCATE THE CONSUMER AND RAISE BUILDING STANDARDS IN THE COMMUNITY.

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IN THE NEXT 12 PAGES YOU WILL SEE HOW A HOUSE CAN BE HEATED MORE EFFICIENTLY BY REARRANGING & MODIFYING SOME OF ITS BASIC ELEMENTS.

GRAPHS

ALL GRAPHS IN THIS STUDY ARE DRAWN TO THE SAME SCALE TO SHOW HOW THE HOURLY HEAT LOSS CHANGES AS THE HOUSE IS MODIFIED. THEY ALSO SHOW PROPORTIONATELY HOW MUCH HEAT IS LOST THROUGH VARIOUS PARTS OF THE HOUSE'S EXTERIOR SURFACES.

ARROWS

HEAT LOSS & SOLAR GAIN ARE SHOWN BY ARROWS. HEAT LOSS ARROWS ARE SHOWN POINTING AWAY FROM THE HOUSE. SOLAR GAIN ARROWS ARE SHOWN POINTING TOWARDS THE HOUSE. THESE ARROWS ARE SHOWN IN PROPORTION TO ONE ANOTHER AND TO THE GRAPHS.

EXTREME JANUARY DAY GRAPHS

THESE GRAPHS SHOW THE HEAT LOSS AND SOLAR GAIN ON A COLD JANUARY DAY WHEN IT IS 10°F OUTSIDE & 70°F INSIDE.

AVERAGE JANUARY DAY GRAPHS

THESE GRAPHS SHOW THE HEAT LOSS AND SOLAR GAIN ON AN AVERAGE JANUARY DAY WHICH HAS A CONSTANT TEMPERATURE OF 45°F AND WHICH IS 50% SUNNY AND 50% CLOUDY DURING THE DAYLIGHT HOURS.

STUDY HOUSE #1

A TYPICAL SINGLE FAMILY RANCH STYLE HOUSE

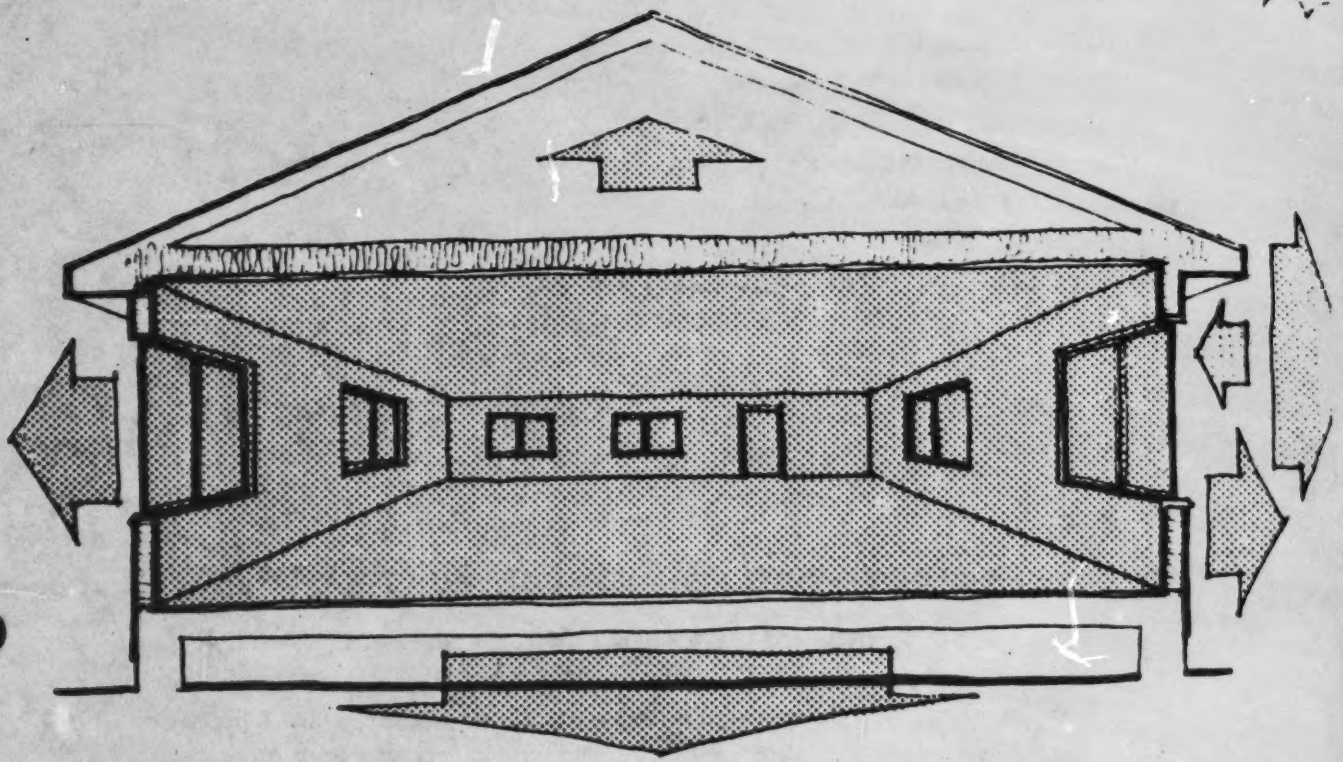
1440 S.F.
1 STORY
3" FIBERGLASS IN WALLS
6" FIBERGLASS IN ROOF
NO INSULATION IN FLOOR
SINGLE PANE GLASS
GLASS ON ALL WALLS
216 S.F. GLASS
INFILTRATION: 1 AIR CHANGE PER HOUR

WHAT IS HEAT LOSS?

THE HEAT LOSS OF A HOUSE IS THE HEAT WHICH ESCAPES FROM THE HOUSE TO THE COLD OUTSIDE AIR. THIS LOSS IS EXPRESSED IN BTU's/HR.* SOME EXTERIOR SURFACES SUCH AS GLASS WILL LOSE HEAT AT A FASTER RATE THAN OTHERS SUCH AS INSULATED WALLS. THE HEAT LOSS ARROWS IN THE HOUSE DIAGRAMS SHOW, BY THEIR RELATIVE SIZES & DIRECTIONS, THE AMOUNT OF HEAT LOST THROUGH THE HOUSE'S EXTERIOR SURFACES DURING A 1 HOUR PERIOD.

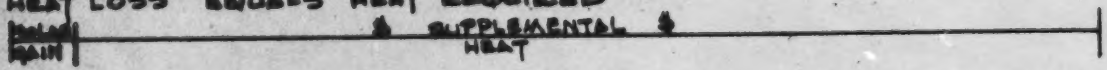
* BTU (BRITISH THERMAL UNIT) = THE AMOUNT OF HEAT NEEDED TO RAISE 1 LB. OF WATER 1°F.

44



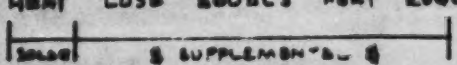
EXTREME JANUARY DAY 10° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED



AVERAGE JANUARY DAY 45° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED



45

STUDY HOUSE # 2

REDUCE EXTERIOR SURFACE AREA

SAME AS HOUSE #1

1440 SF

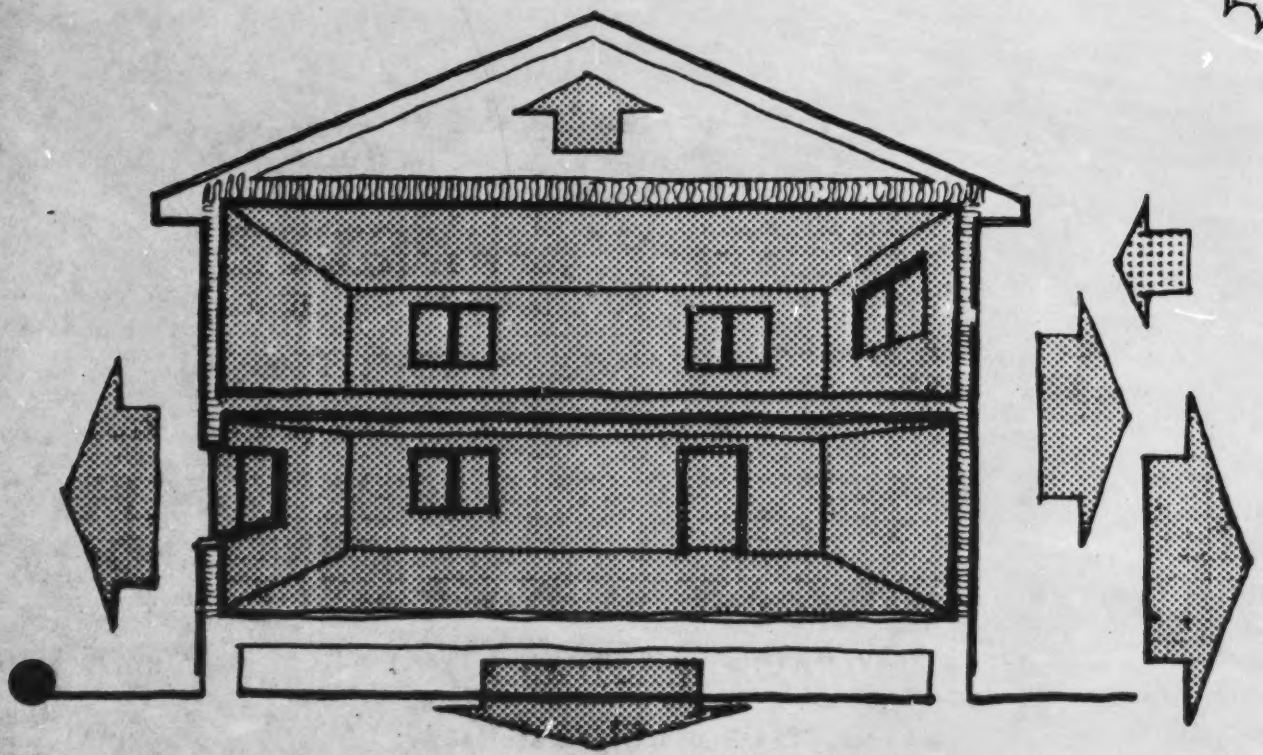
3" FIBERGLASS IN WALLS
6" FIBERGLASS IN ROOF
NO INSULATION IN FLOOR
SINGLE PANE GLASS
GLASS ON ALL WALLS
216 S.F. GLASS
INFILTRATION: 1 AIR CHANGE PER HOUR

CHANGE FROM HOUSE #1

2 STORY

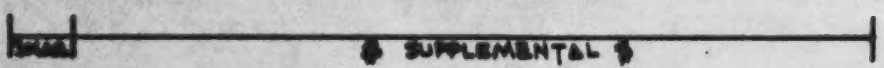
HOW DOES HOUSE SHAPE AFFECT HEAT LOSS?

THE PROPORTION OF EXTERIOR SURFACE AREA TO FLOOR AREA WILL VARY DEPENDING UPON THE SHAPE OF THE HOUSE. A HOUSE'S HEAT LOSS IS DIRECTLY PROPORTIONAL TO THE AREA OF THE HOUSE'S EXTERIOR SURFACE. IN THE STUDY HOUSE THE PROPORTION OF EXTERIOR SURFACE AREA TO FLOOR AREA IS REDUCED BY MAKING IT 2 STORIES. THE HEAT LOSS WAS REDUCED 32% BY THIS CHANGE ALONE.



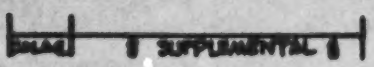
EXTREME JANUARY DAY 10° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED



AVERAGE JANUARY DAY 40° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED



STUDY HOUSE #3

INCREASE INSULATION

SAME AS HOUSE #2

1440 S.F.
2 STORY

GLASS ON ALL WALLS
216 S.F. GLASS

CHANGE FROM HOUSE #2

6" FIBERGLASS IN WALLS
9" FIBERGLASS IN ROOF
6" FIBERGLASS IN FLOOR
INSULATING GLASS

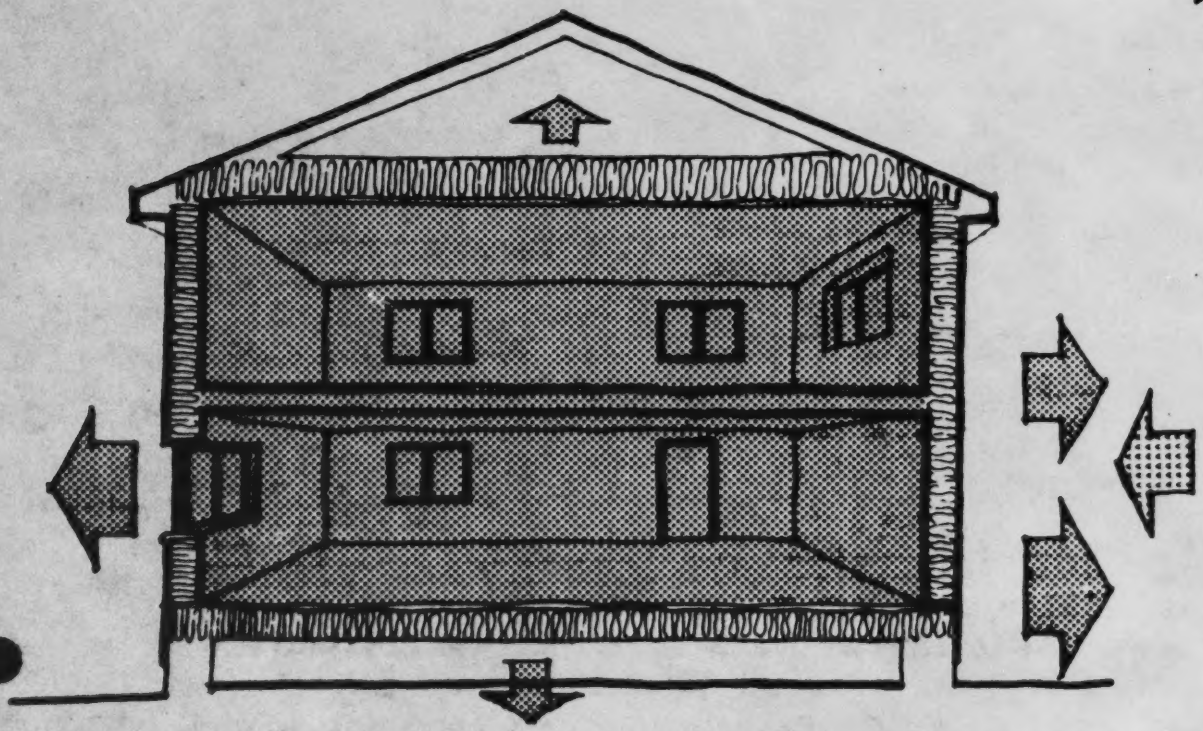
½ AIR CHANGE PER HOUR

HOW IS INSULATION'S EFFECTIVENESS MEASURED?

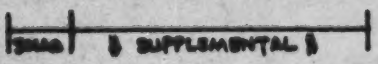
THE "R" VALUE OF A MATERIAL EXPRESSES ITS RESISTANCE TO HEAT FLOW THROUGH IT. THE HIGHER THE "R" VALUE, THE GREATER THE RESISTANCE.

"R" VALUES PER 1" THICKNESS OF SOME COMMON MATERIALS

WOOD	R = 1.25
BRICK	R = .11
GLASS - SINGLE PANE	R = .85
GLASS - INSULATING	R = 1.72
AIR SPACE	R = 1
FIBERGLASS	R = 3.10
UREA FORMALDAHYDE FOAM	R = 4.6
URETHANE FOAM	R = 5.56
CELLULOSE INSULATION	R = 4.5
STYROFOAM	R = 3.45



EXTREME JANUARY DAY 10° OUTSIDE TEMP.



AVERAGE JANUARY DAY 40° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED

STUDY HOUSE #4

MOVE ALL WINDOWS TO SOUTH SIDE OF HOUSE

SAME AS HOUSE #3

1440 S.F.
2 STORY
6" FIBERGLASS IN WALLS
9" FIBERGLASS IN ROOF
6" FIBERGLASS IN FLOOR
INSULATING GLASS

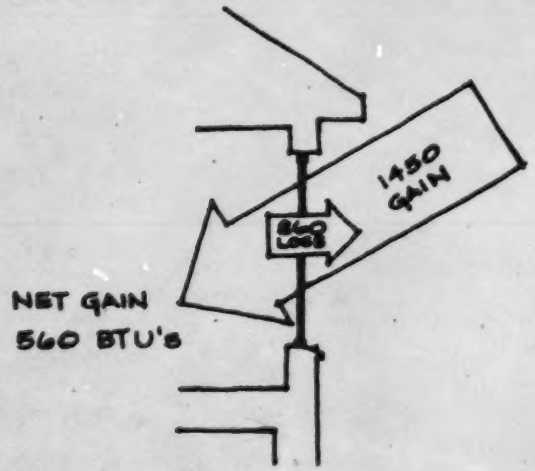
216 S.F. GLASS
½ AIR CHANGE PER HOUR

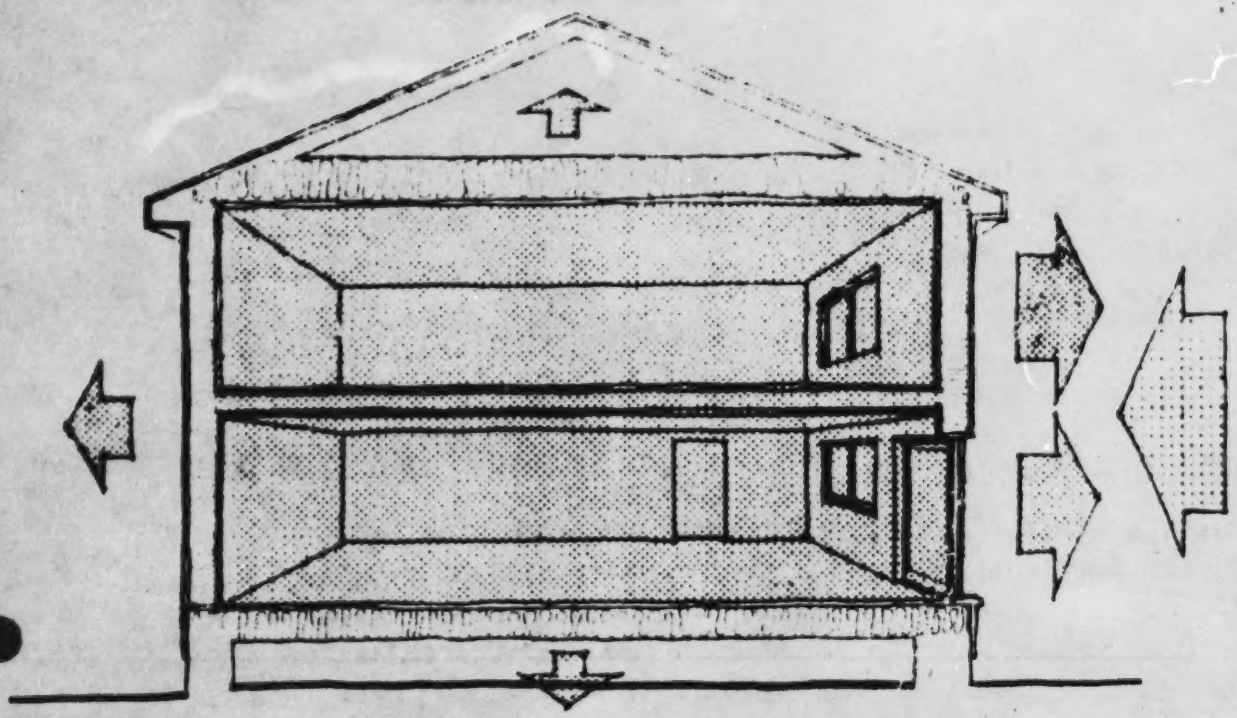
CHANGE FROM HOUSE #3

GLASS ON S. SIDE ONLY

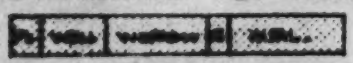
WHAT IS SOLAR GAIN?

SOLAR GAIN IS THE HEAT GAINED FROM THE SUN. ON A CLEAR JANUARY DAY IN CHAPEL HILL APPROXIMATELY 1450 BTU'S OF HEAT WILL BE GAINED THROUGH EACH SQUARE FOOT OF SOUTH FACING WINDOW. ANY WINDOW WILL HAVE A DAILY LOSS OF 860 BTU'S PER SQUARE FOOT WITH INSULATING GLASS. THEREFORE, THE DAILY NET GAIN THROUGH A SOUTH FACING WINDOW WILL BE ABOUT 560 BTU'S PER SQUARE FOOT.



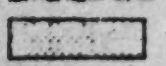


EXTREME JANUARY DAY 10° OUTSIDE TEMP.

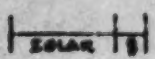


HEAT LOSS EQUALS HEAT REQUIRED

AVERAGE JANUARY DAY 45° OUTSIDE TEMP.



HEAT LOSS EQUALS HEAT REQUIRED



STUDY HOUSE #5

INCREASE SOUTH GLASS TO MAXIMUM

SAME AS HOUSE #4

1440 S.F.
2 STORY
6" FIBERGLASS IN WALLS
9" FIBERGLASS IN ROOF
6" FIBERGLASS IN FLOOR
INSULATING GLASS
GLASS ON S. SIDE ONLY

½ AIR CHANGE PER HOUR

CHANGE FROM HOUSE #4

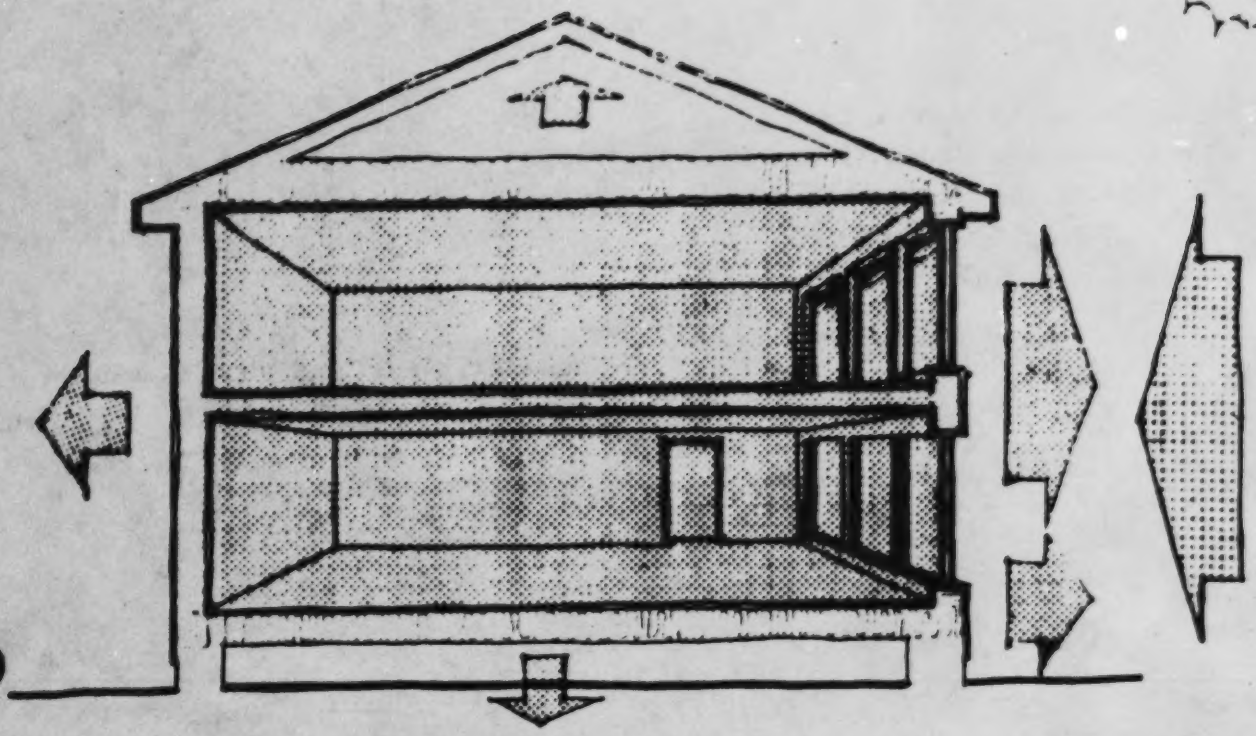
384 S.F. OF GLASS

WHAT IS A PASSIVE SOLAR HOUSE?

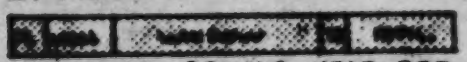
A PASSIVE SOLAR HOUSE DEPENDS ON NATURAL HEAT FORCES TO GAIN, STORE & DISTRIBUTE HEAT. NO OUTSIDE SOURCES OF ENERGY ARE NECESSARY. THE PASSIVE SOLAR HOUSE DEPENDS UPON LOW HEAT LOSS, HIGH SOLAR GAIN & THE USE OF HEAT RETENTIVE MATERIALS IN CONSTRUCTION FOR STORING HEAT. SOME SWING OF INSIDE TEMPERATURE CAN BE EXPECTED IN A PASSIVE SOLAR HOUSE.

WHAT IS AN ACTIVE SOLAR HOUSE?

AN ACTIVE SOLAR HOUSE USES AUTOMATIC, MECHANICAL MEANS OF TRANSFERRING HEAT FROM COLLECTORS, TO STORAGE & BACK TO THE HOUSE. THESE MACHINES USUALLY REQUIRE AN OUTSIDE SOURCE OF ENERGY. THERE CAN BE A HIGH DEGREE OF CONTROL OF INSIDE TEMPERATURES, SINCE HEAT IS STORED SUCH THAT IT CAN BE DRAWN ON AT WILL.

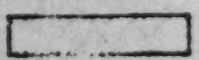


EXTREME JANUARY DAY 10° OUTSIDE TEMP.

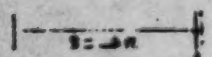


HEAT LOSS EQUALS HEAT REQUIRED

AVERAGE JANUARY DAY 46° OUTSIDE TEMP



HEAT LOSS EQUALS HEAT REQUIRED



EXCESS SOLAR GAIN

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STUDY HOUSE #6

ADD OPERABLE INSULATING SHUTTERS

SAME AS HOUSE #5

1440 S.F.
2 STORY
6" FIBERGLASS IN WALLS
9" FIBERGLASS IN ROOF
6" FIBERGLASS IN FLOOR
INSULATING GLASS
GLASS ON S. SIDE ONLY
384 S.F. OF GLASS

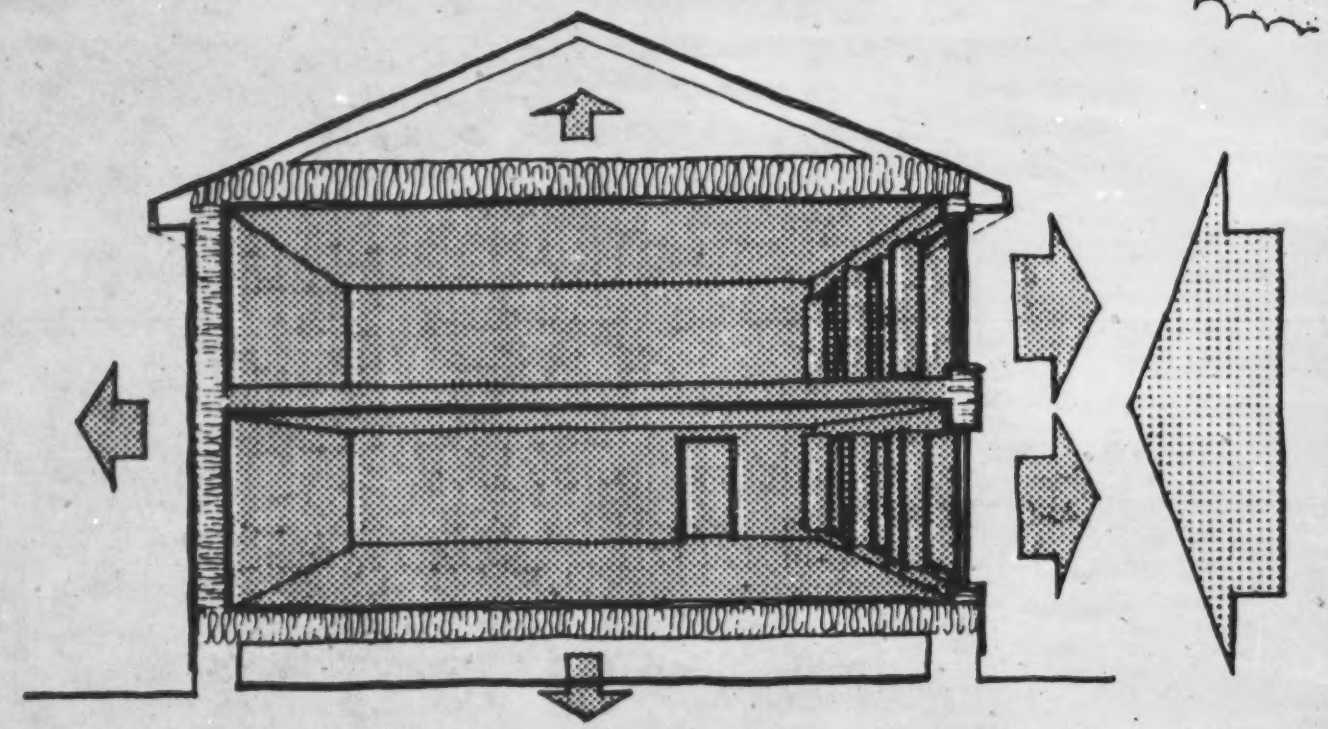
½ AIR CHANGE PER HOUR

CHANGE FROM HOUSE #5

OPERABLE SHUTTERS ON GLASS

WHY MOVABLE INSULATION?

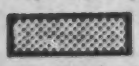
GLASS HAS A VERY HIGH HEAT LOSS POTENTIAL. THEREFORE, MUCH OF THE HEAT GAINED DURING THE DAY WILL BE LOST IF THERE IS NOT SOME WAY TO TRAP IT IN THE HOUSE. MOVABLE INSULATION CAN PROVIDE SUCH A TRAP. IT CAN BE REMOVED DURING THE DAY TO LET THE SUN'S HEAT IN & REPLACED AT NIGHT TO PREVENT ITS ESCAPE. OPERABLE SHUTTERS SHOWN IN THE STUDY HOUSE ARE ONE FORM OF MOVABLE INSULATION.



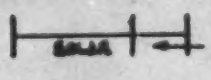
EXTREME JANUARY DAY 0° OUTSIDE TEMP.

HEAT LOSS EQUALS HEAT REQUIRED

AVERAGE JANUARY DAY 45° OUTSIDE TEMP.



HEAT LOSS EQUALS HEAT REQUIRED

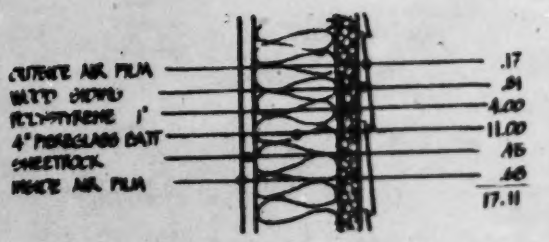


FURTHER POSSIBLE MODIFICATIONS

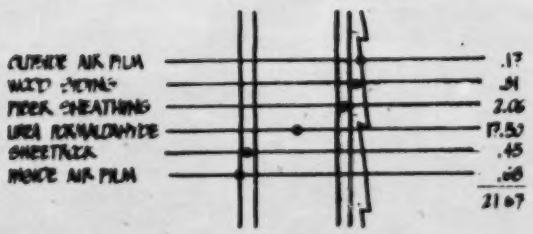
THE AVERAGE JANUARY DAY IN THIS STUDY IS A THEORETICAL DAY USED TO ILLUSTRATE THE AMOUNT OF HEAT REQUIRED COMPARED TO THE AMOUNT OF SOLAR GAIN AVAILABLE DURING THE COLDEST MONTH. IN REALITY THERE IS NO SUCH DAY. TEMPERATURES RISE & FALL WITHIN EACH DAY, & CLOUDY & SUNNY DAYS COME IN SERIES. OUR MOST EFFICIENT STUDY SOLAR HOUSE WOULD GAIN EXCESS SOLAR HEAT ON SUNNY DAYS & LOSE HEAT ON CLOUDY DAYS. TO FURTHER IMPROVE OUR SOLAR HEATING SYSTEM WE CAN ADD STORAGE TO THE HOUSE, USUALLY CONSISTING OF ROCKS, MASONRY OR WATER, TO SAVE THE EXTRA HEAT GAINED ON SUNNY DAYS FOR NIGHTS & CLOUDY DAYS WHEN SUPPLEMENTAL HEAT WOULD OTHERWISE BE REQUIRED.

ALTERNATIVES IN WALL CONSTRUCTION

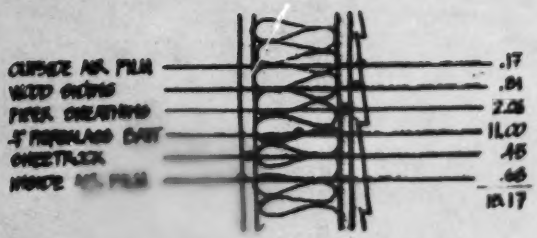
THE FOLLOWING SECTIONS SHOW SOME ALTERNATIVES IN WALL CONSTRUCTION USING A NUMBER OF LOCALLY AVAILABLE MATERIALS. THE INSULATING VALUE OF THESE WALLS & THEIR APPROXIMATE COSTS ARE SHOWN.



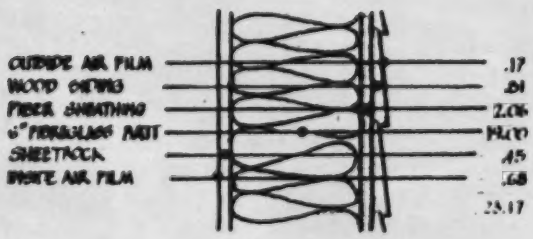
4' STUD WALL 5¼¢/R
R-17
U-.056
¢.88/SF



4' STUD WALL 4¢/R
R-22
U-.045
¢.65/SF

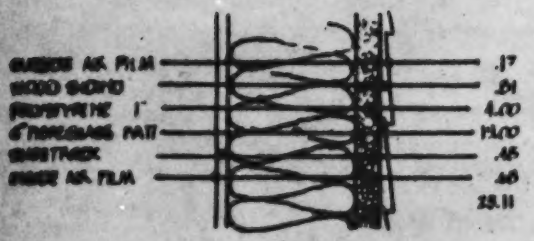


4' STUD WALL 4½¢/R
R-15
U-.066
¢.69/SF

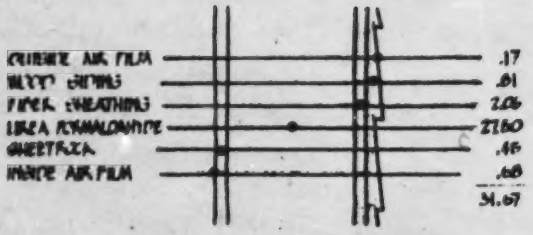


6" STUD WALL 3¼¢/R
R-23
U-.043
¢.78/SF

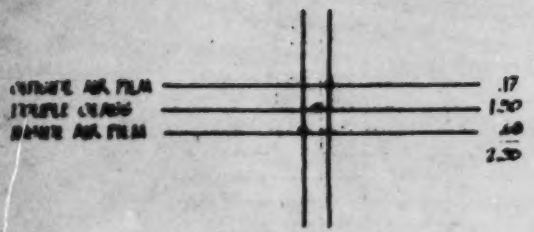
57



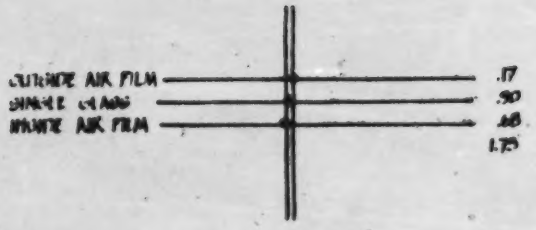
6" STUD WALL 4¢/R
R-25
U-.04
¢.96/SF



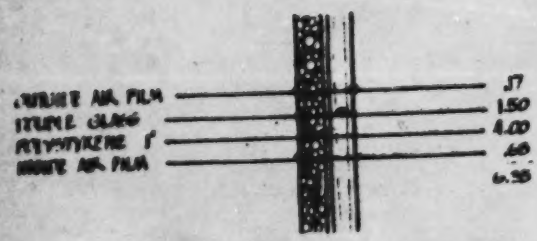
6" STUD WALL 3½¢/R
R-32
U-.03
¢1.08/SF



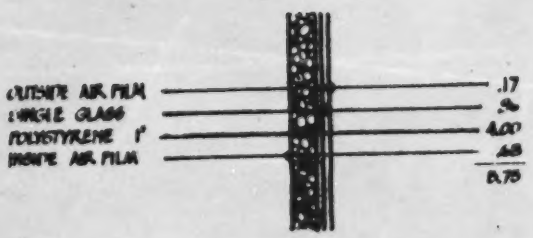
INSULATING GLASS 19¢/R
R-2.35
U-.42
¢4.65/SF



GLASS 8G¢/R
R-1.75
U-.57
¢1.50/SF



INSULATING GLASS & SHUTTER
R-6.35 7G¢/R
U-.15
¢4.84/SF



GLASS with SHUTTER 46¾¢/R
R-5.75
U-.17
¢2.69/SF

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 2) LIST BASIC ENERGY NEEDS FOR DWELLING

COMPETENCY: UNDERSTAND THE TYPES AND AMOUNTS OF ENERGY NEEDED IN THE HOME

CRITERION MEASURE:
KNOWS THE TYPES OF ENVIRONMENTAL SYSTEMS REQUIRED IN THE HOME
UNDERSTANDS ALTERNATIVES TO CONVENTIONAL SYSTEMS
PLANS HOUSE FOR ENERGY EFFICIENT OPERATION

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. List types of systems requiring energy input for dwelling	I. Mechanical Systems A. Heating 1. Water 2. House B. Cooking C. Lighting D. Cooling (ventilation)	I. Understanding where energy is really needed, where energy can be conserved or adjusted to an alternative
II. List methods of operating systems compatible with dwelling and site	II. Energy Sources A. Electric B. Gas--propane, methane, butane C. Oil D. Wood E. Solar--passive and active F. Wind G. Water	II. Realizing where energy comes from and how to use renewable energy resources to generate a local source of power

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 3) LIST PERSONAL ABILITIES (IN RELATION TO BUILDING A HOUSE)

COMPETENCY: UNDERSTAND WHAT WORK THE INDIVIDUAL CAN DO AND WHERE SUBCONTRACTORS MAY BE NEEDED

CRITERION MEASURE:
DEFINES PERSONAL CAPABILITIES
CONFIRMS AREAS OF POTENTIAL CAPABILITIES
IDENTIFIES CRITICAL AREAS THAT NEED TO BE SUBCONTRACTED

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. List areas of personal capabilities.	I. What can individual do A. Skills necessary B. Tools available	I. Discovery of what individual can do and the tools needed
II. List tasks individuals could do if they took their time to learn.	II. Things individual could do A. Skills necessary B. Tools available C. Comparative cost	II. Find personal limitations as to what individual can and cannot do
III. List tasks that require a license or skills individual does not have the time or inclination to learn.	III. Things individual cannot do A. Tasks requiring a licensed person B. Tasks individual does not want to do C. Tasks individual is not capable of doing	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 4) DEFINE THE TYPES OF BUILDING SPACES REQUIRED

COMPETENCY: TO PUT IN ORDER THE GENERAL QUALITIES AND CHARACTERISTICS THE OWNER-BUILDER FEELS THAT IT IS DESIRABLE TO HAVE

CRITERION MEASURE:
DEFINES TYPES OF SPACES DESIRED IN HOUSE
DESCRIBES QUALITIES THOSE SPACES SHOULD HAVE
IDENTIFIES FURNITURE OR EQUIPMENT WHICH MUST FIT WITHIN THOSE SPACES

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. List different types of spaces needed.	I. What spaces does individual/family require A. Sleeping area(s) B. Cooking area(s) C. Social/multipurpose area(s) D. Bathroom(s) E. Study/library area(s) F. Studio/work area(s) G. Eating area(s) H. Others	I. Understanding of the kinds of needs house should meet.
	II. Possible combination of spaces A. Cooking-eating area B. Social-eating area C. Library-studio area(s) D. Sleeping-study area(s) E. Other combinations	II. Ability to create functional spaces in house and get the most out of the sq. ft.
II. Know characteristics for these spaces.	III. Characteristics for each place A. Lighting B. Privacy (access) C. Relative size D. Finish materials	
III. List of equipment or furniture necessary	IV. Furnishings A. Types of furniture B. Can they be built in? C. Can they be eliminated?	III. Find the kind of furniture that is durable, low cost and fits life-style.

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 5) DESCRIBE ENVIRONMENTAL CONTROLS FOR HOUSE

COMPETENCY: UNDERSTAND ALL TYPES OF SYSTEMS AVAILABLE, INCLUDING ALTERNATIVES
CONSIDER COST AND LIFESTYLE

CRITERION MEASURE: SELECTS BEST SYSTEMS FOR HOUSE, LOCATION AND LIFESTYLE
FULL CONSIDERATION OF ALTERNATIVE SYSTEMS
CONSIDERATIONS FOR COSTS (FRONT END, LIFE CYCLE, OPERATIONAL, ECOLOGICAL, SOCIAL)

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Understand environmental systems needs	I. Types of systems A. Jobs required of systems 1. Heating a) Whole house b) Water 2. Cooling 3. Ventilation 4. Operate appliances 5. Other B. Modes of operation 1. Oil 2. Gas 3. Electric 4. Solar 5. Wood 6. Wind 7. Water 8. Other	I. Become aware of the systems that will fit the location and that will add quality to and simplify lifestyle.

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
II. Understanding of the full cost of systems	II. List costs for systems selected A. Front end (initial) costs 1. Equipment 2. Labor B. Lifecycle (overall) costs C. Operational 1. Replacement parts 2. Servicing 3. Fuel D. Ecological 1. Use of renewable resources 2. Possibility/Probability of radioactive contamination from nuclear power plants E. Social 1. Wise use of resources 2. Decentralization of utilities 3. Self-sufficiency from independent energy sources	II. Be aware of systems which can be managed by the landowner, systems which are most energy efficient and respectful of natural resources

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 6) LIST BASICS FOR OPERATING HOUSE FOR MAXIMUM EFFICIENCY

COMPETENCY: KNOW HOW TO OPERATE HOUSE SO THAT IT WILL BE MOST ENERGY EFFICIENT AND A COMFORTABLE ENVIRONMENT TO LIVE IN

CRITERION MEASURE:
- KNOWS HOW TO MAINTAIN MECHANICAL SYSTEMS
- KNOWS HOW TO PREVENT ENERGY LEAKS
- TAKES ADVANTAGE OF NATURAL VENTILATION
- BUYS AND USES ENERGY SAVING APPLIANCES
- DEVELOPS ENERGY SAVING HABITS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Know servicing routine for mechanical systems	I. Mechanical systems servicing A. Clean furnace filters B. Clean woodstove flue C. Set thermostats for proper summer or winter temperatures D. Clean thermostats yearly E. Lubricate fans and motors and bearings F. Insulate water heater G. Have serviceman check systems periodically	I. Be aware of how to operate systems for top efficiency.
II. Prevent energy leaks	II. Preventing energy leaks A. Caulk and seal any cracks in siding B. Seal leaks in air ducts with duct tape C. Weatherstrip all exterior windows and doors	II. Understand maintenance technique to prevent energy leaks
III. Use natural ventilation wherever possible	III. Using natural ventilation A. Open windows and doors on shady side of house to cool house in summer B. Plant deciduous trees on south side of house to shade in summer	III. Understand systems of natural ventilation to cut energy consumption

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OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
IV. Use energy saving appliances	IV. Saving energy with appliances A. Turn off lights when not in use B. Reduce bulb size in lights and install dimmer switches C. Use hot water only when absolutely necessary D. Use a clothesline instead of a dryer whenever possible E. When buying appliances look for one with a high EER (Energy Efficiency Ratio)	IV. Interest in how to use energy with discretion

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 7) LIST NECESSARY CONSIDERATIONS FOR OPERATING PASSIVE SOLAR GREENHOUSE

COMPETENCY: UNDERSTAND THE ADVANTAGES AND DISADVANTAGES OF OWNING AND OPERATING A GREENHOUSE

CRITERION MEASURE:
DETERMINES TYPE AND PLACEMENT OF GREENHOUSES
UNDERSTANDS TYPES OF COVERING MATERIALS FOR GREENHOUSE
DETERMINES NEED FOR GREENHOUSE VENTILATION
UNDERSTANDS HOW TO SUPPLEMENT HEATING WITH A GREENHOUSE

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. List types of greenhouses and where they can be located	I. Placement of greenhouses A. Attached to south side of house 1. Walled-in porch 2. Shed-type greenhouse B. Solarium C. Separate greenhouse unit	I. Consider the usefulness of a greenhouse for house
II. Know characteristics of covering materials	II. Considerations A. Materials 1. Glass 2. Plexiglass 3. Fiberglass B. Insulating qualities C. Light-admitting qualities D. Cost E. Purpose 1. Heating 2. Food 3. Hobby	II. Understand what materials will best suit needs

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
III. Know importance of ventilation	III. Reasons for ventilation A. Winter 1. Greenhouses attached to house (porch, lean-to and solarium) ventilate into house to supplement heating 2. Separate greenhouses need no ventilation--they may need heat B. Summer--all greenhouses need ventilation to outside	III. Understand the concepts by which a greenhouse works
IV. Ways to supplement heating	IV. Supplementing heat in winter A. Use attached greenhouse on south side B. Open window or door into house C. Use thermal ballast to maintain a more consistent greenhouse temperature D. Use circulating fans E. Black plastic on wall F. Grow winter plants to help humidify	IV. Ability to use a greenhouse most effectively

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: PLANNING

TASK: (No. 8) MAKE A COMPREHENSIVE LIST OF ALL FINANCING CONSIDERATIONS

COMPETENCY: TO HAVE A KNOWLEDGE OF ALL AVAILABLE FINANCIAL RESOURCES

CRITERION MEASURE:
KNOWS APPROXIMATELY HOW MUCH MONEY WILL BE NEEDED TO BUILD HOUSE
KNOWS HOW MUCH MONEY IS ON HAND TO BE SPENT ON A HOUSE (SAVINGS)
KNOWS HOW MUCH MONEY CAN BE BORROWED AND WHAT THE INTEREST RATE AND PAYMENT SCHEDULE IS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Compare finances needed with finances available	I. Consideration A. Money needed 1. Cost of materials 2. Cost of labor 3. Cost of site B. Money available 1. Savings 2. Relatives 3. Second mortgage (if you already own a home) C. Determine approximate amount needed (A-B=C)	I. Determining financial ability to pay for a home
II. Inquire at lending institutions	II. Considerations A. Types of institutions 1. Bank 2. Savings and loan 3. Credit union B. Amount of loan C. Interest rate D. Payment schedule E. Limitations of dwelling 1. Size 2. Mechanical systems 3. Materials 4. Style of dwelling	

REFERENCES (see Bibliography for complete information)

Major Texts:

The Woodburners Encyclopedia is the best text for anyone considering wood heat. It includes sections on theories, practice and equipment relating to wood heat.

The Solar Home Book (see description in previous section).

From the Ground Up (see description in previous section).

Other Helpful References:

The Limits to Growth is a Club of Rome study which considers global energy (resource) consumption and makes predictions concerning life of various known reserves.

Fireplaces is the latest publication of Ken Kern and Steve Majers and is an excellent source of information about constructing energy-efficient fireplaces.

The Forgotten Art of Building a Good Fireplace is a historical and technical discussion of the work of Count Rumford, who basically designed and perfected an energy-efficient fireplace in the late 18th century.

The Arkansas Story is a publication documenting the construction of energy efficient houses for the mass market and savings effected.

Earth Sheltered Houses is an excellent text for individuals considering building an underground house. It includes design and technical information as well as actual examples.

30 Energy Efficient Houses presents various energy conscious heating/cooling systems in recently constructed owner-built homes.

SITE

SITE

The purpose of this section is to assist individuals in gaining information and making decisions necessary to successfully and legally integrate their house with its site. Generalized discussion is of course possible but it is suggested that the instructor have available house sites in the community for study by students who do not have a specific site.

There are two general areas of consideration. The first is requirements that are brought to bear by social forces (zoning, utilities, inspectors) and second, the environment of the specific site (slope, sun orientation, ventilation, etc.).

Before individuals can begin to analyze their own needs and the way they can be put on to the site, it is imperative that they determine the external factors which may influence these decisions. The form included is generalized. Take care to add additional authorities who may have jurisdiction in your particular region. Emphasis should be made on recording names or authorities who provide information in case further questions should arise on the quality of previously given information. The site planning form which is included will help the student organize this information for future access.

The second area of consideration is that of the specific site environment. The student, with a copy of his/her plot plan should make a detailed inspection of the site, noting specifically areas of consideration listed on the Site Planning Form. The student should, as a result of his/her investigation, prepare site analysis and preliminary site design drawings for their specific site similar to the case house samples which are included with the handouts.

HANDOUT #6

SITE PLANNING FORM

External Site Analysis

Planning and zoning authority _____

Contact person _____ Phone Number _____

Tract in _____ Zone

Specific restrictions (List minimum lot size, setbacks, use restrictions, etc.)

Health Department _____ Phone Number _____

Contact Person _____ Phone Number _____

Percolation Test _____

Tank size, length of leaching field _____

Specific requirements for well _____

Inspection and permit required _____

Building inspection _____

Contact Person _____ Phone Number _____

Codes having jurisdiction (list) _____

Inspections and permits required _____

Deed Restrictions

List restrictions: minimum square footage, appearance committee (local, city or subdivision), materials, setbacks, easements, right of ways.

Road Access

If road is in private ownership. List provisions of maintenance agreement.

_____

Utilities

Water Sewer:

Utility Ownership _____

Contact Person _____ Phone Number _____

Location of water and sewer _____

Estimated cost of tap-on _____

Extension of line _____

Service rates _____

Electricity

Utility ownership _____

Contact person _____ Phone Number _____

Location of nearest service _____

Basic fee _____

Fee for underground _____

Right of way agreements _____

Requirements for temporary service _____

Rates _____

Natural Gas

Utility name _____

Contact person _____ Phone Number _____

Location of nearest service _____

Tap-on fee _____

Per foot price for pipe _____

Right of way agreements _____

Rates _____

Garbage and Trash Pickup

(Requirements for containers)

On-Site Analysis:

On a sketch of the site (surveyor's plot preferable) note the following:

1. Slope (direction and amount of slope)

2. Compass orientation

3. Vegetation type

    a. Deciduous trees
    b. Conifers
    c. Shrubs, etc.

4. Views

    a. Good (use arrows)
    b. Bad
    c. Short distance views
    d. Long distance views

5. Locate site utilities (with alternatives)

    a. Water (well)
    b. Sewer (septic tank and leaching field)
    c. Telephone
    d. Driveway

6. Subsurface and drainage conditions

    a. Boggy soil
    b. Flood plain
    c. Drainage ways, etc.

7. Location of or direction to road

8. Garden site and provision for animals

HANDOUT #7

SITE PLANNING FORM
CASE HOUSE

External Site Analysis

Planning and zoning authority town of Piedmont, N.C.

Contact person Ralph Ames Phone Number 934·1654

Tract in R·20 Zone

Specific restrictions (List minimum lot size, setbacks, use restrictions, etc.)
20' side yard, 50' Rear & front yard setbacks

Health Department White County Phone Number 934·8163

Contact Person Fred Givens Phone Number " "

Percolation Test approved prior to closing (3/21/77)

Tank size, length of leaching field 1200 gal. 500LF

Specific requirements for well MIN 100' from septic system

Inspection and permit required yes· before covering leach field

Building inspection town of Piedmont

Contact Person John Adams Phone Number 934-3163

Codes having jurisdiction (list) N.C. Res. code

Inspections and permits required BUILDING, ELECTRICAL, PLUMBING, INSULATION

Deed Restrictions

List restrictions (minimum square footage, appearance committee (local, city or subdivision), materials, setbacks, easements, right of ways.

3 neighbors must approve prelim. design.

Road Access

If road is in private ownership. List provisions of maintenance agreement.

private ownership as per deed covenants

Utilities

Water Sewer: well and septic tanks

Utility Ownership _____

Contact Person _____ Phone Number _____

Location of water and sewer _____

Estimated cost of tap-on _____

Extension of line _____

Service rates _____

Electricity

Utility ownership Trinity Power

Contact person Thomas Flood Phone Number 682-1368

Location of nearest service Small Pond Lane

Basic fee 40.00 + 2.00 per foot for underground

Fee for underground _____

Right of way agreements will be furnished by Trinity Power

Requirements for temporary service " "

Rates 4.5¢ per kilowatt hour (average)

Natural Gas

Utility name N.A

Contact person _____ Phone Number _____

Location of nearest service _____

Tap-on fee _____

Per foot price for pipe _____

Right of way agreements _____

Rates _____

Garbage and Trash Pickup

(Requirements for containers) FAMILY will take to Landfill or hire private contractor

On-Site Analysis:

On a sketch of the site (surveyors plot preferable) note the following:

1. Slope (direction and amount of slope)

2. Compass orientation

3. Vegetation type

   a. Deciduous trees
   b. Conifers
   c. Shrubs, etc.

4. Views

   a. Good (use arrows)
   b. Bad
   c. Short distance views
   d. Long distance views

5. Locate site utilities (with alternatives)

   a. Water (well)
   b. Sewer (septic tank and leaching field)
   c. Telephone
   d. Driveway

6. Subsurface and drainage conditions

   a. Boggy soil
   b. Flood plain
   c. Drainage ways, etc.

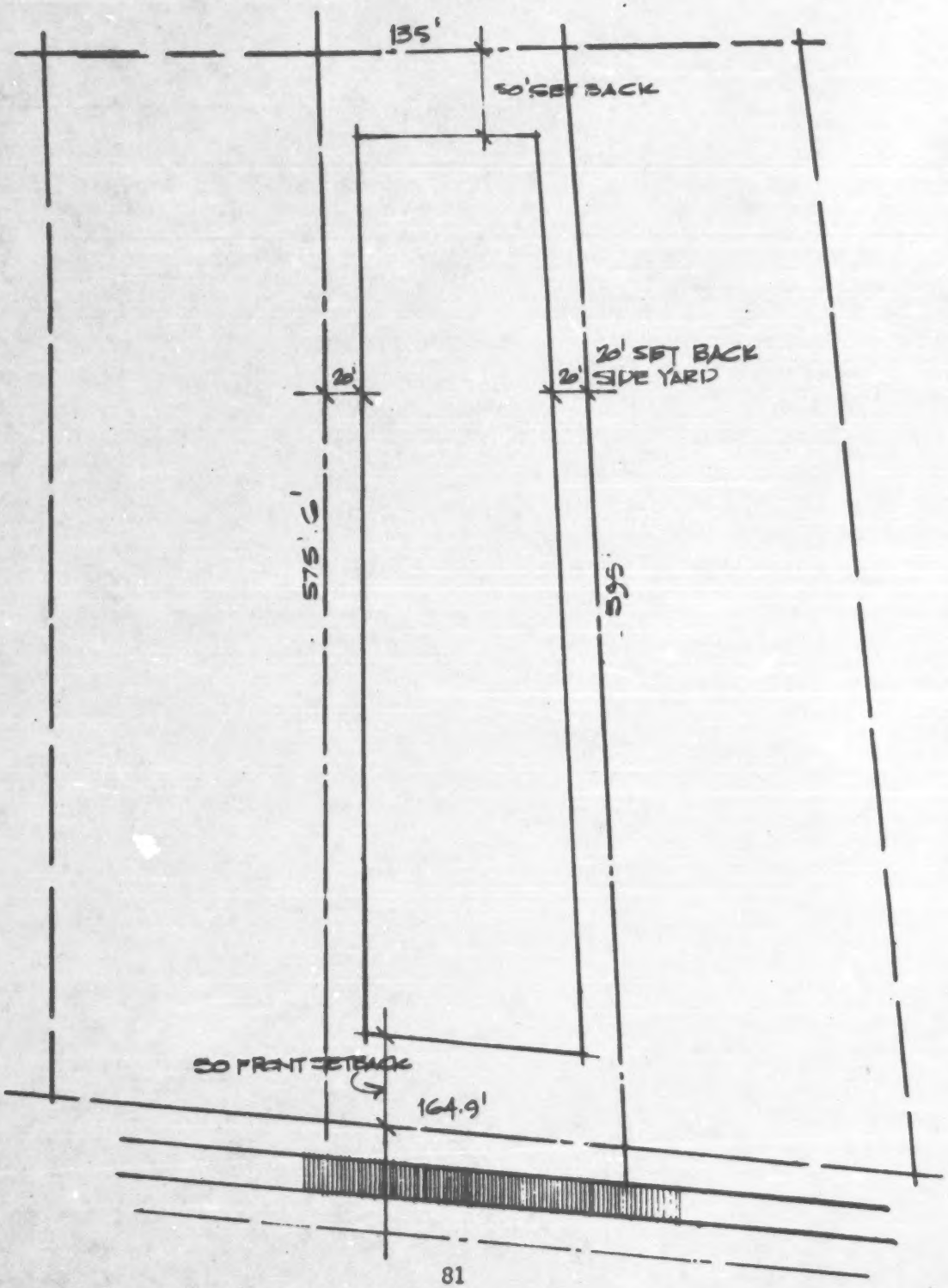
7. Location of or direction to road

8. Garden site and provision for animals

HANDOUT #8

Plot Plan

Case House
Small Pond Lane - Piedmont, N.C.
1" = 30'



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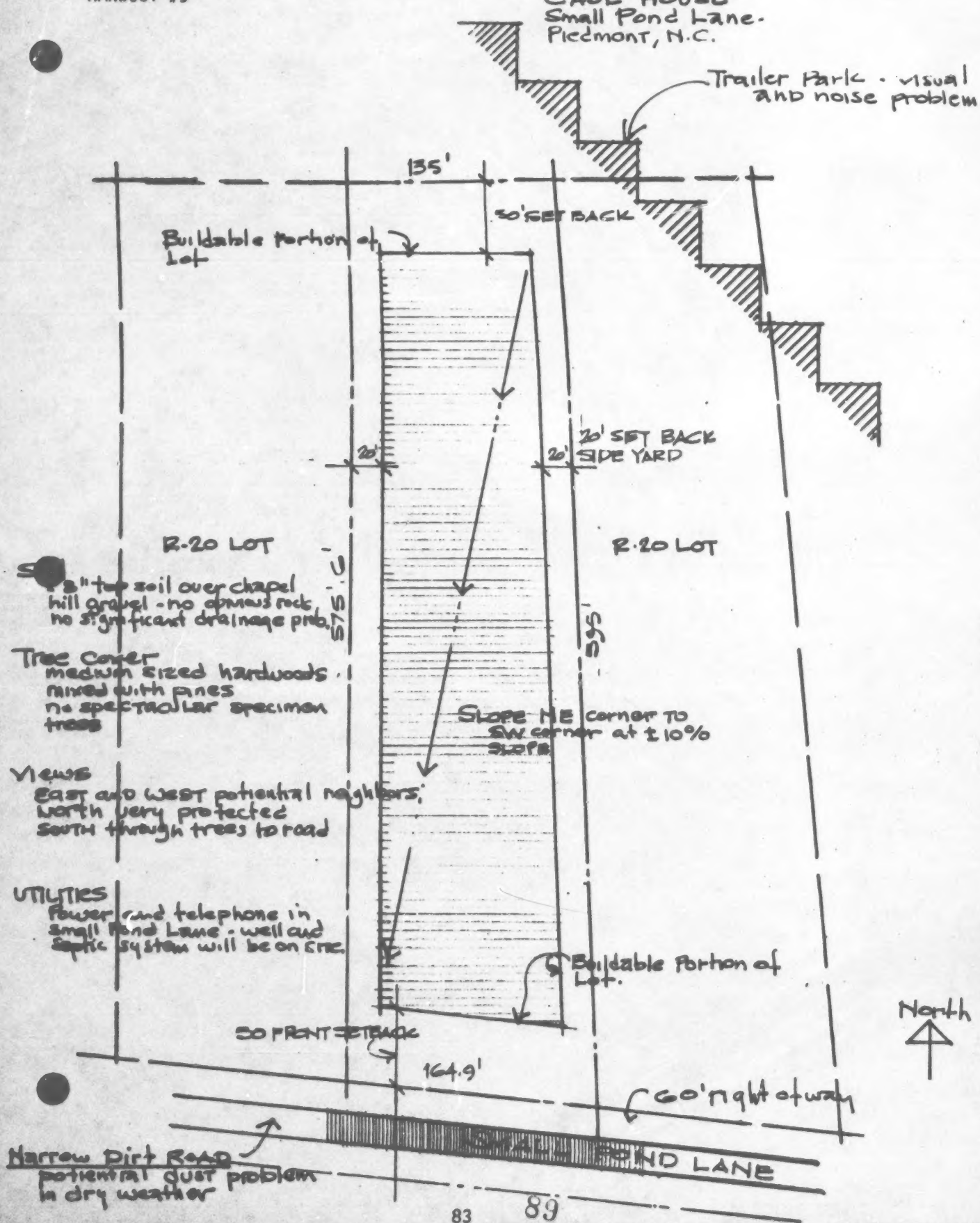
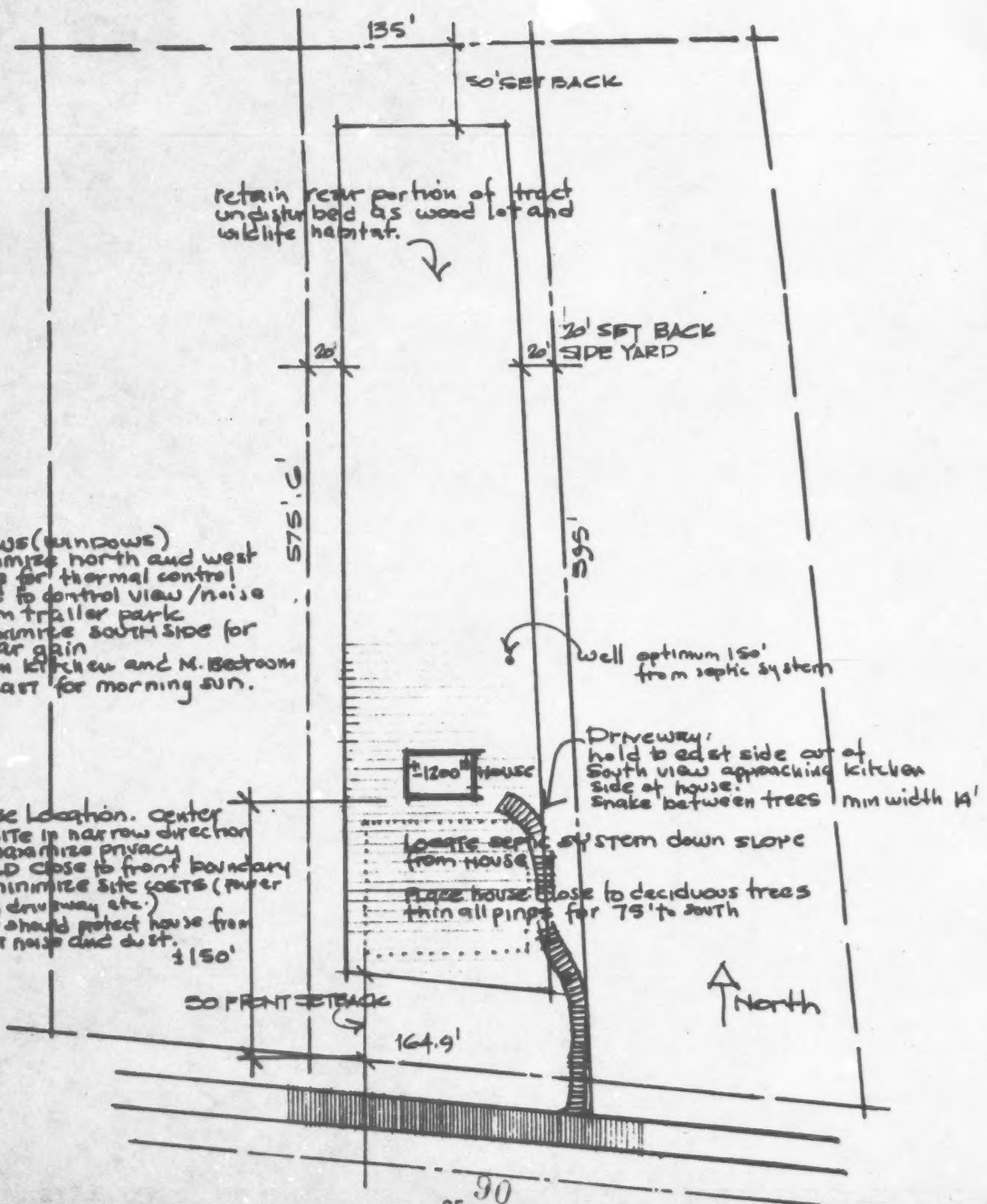
HANDOUT #9

Site Analysis
CASE HOUSE
Small Pond Lane.
Piedmont, N.C.


Trailer Park - visual and noise problem
135'
30' SET BACK
Buildable portion of Lot
20'
20' SET BACK SIDE YARD
20'
R-20 LOT
R-20 LOT
575'
595'
Soil
2" top soil over chapel hill gravel - no obvious rock no significant drainage prob.
Tree Cover
medium sized hardwoods mixed with pines no spectacular specimen trees
Slope NE corner to SW corner at ± 10% slope
Views
East and West potential neighbors; North very protected South through trees to road
UTILITIES
Power and telephone in small Pond Lane - well and septic system will be on site.
Buildable Portion of Lot.
North
30 FRONT SETBACK
164.9'
60' right of way
Narrow Dirt Road
potential dust problem in dry weather
SMALL POND LANE

HANDOUT #10

Prelim. Site design
Case House
Small Pond Lane
PIEDMONT N.C.


135'
50' SET BACK
retain rear portion of tract undisturbed as wood lot and wildlife habitat.
20'
20' SET BACK SIDE YARD
20'
575'±
595'
Views (windows) Minimize north and west side for thermal control and to control view/noise from trailer park maximize south side for solar gain open kitchen and M. Bedroom to east for morning sun.
well optimum 150' from septic system
Driveway: hold to east side out of South view approaching kitchen side of house. Snake between trees min width 14'
±1200 sq ft house
House Location. center on site in narrow direction to maximize privacy HOLD close to front boundary to minimize site costs (sewer tele, driveway etc.) 150' should protect house from most noise and dust. ±150'
Locate septic system down slope from house
Place house close to deciduous trees thin all pines for 75' to south
North
50 FRONT SETBACK
164.9'

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: SITE

TASK: (No. 9) MAP TOPOGRAPHY OF SITE, UNDERSTAND SOILS
(USE HANDOUT #9 FOR SITE ANALYSIS)

COMPETENCY: UNDERSTAND THE LAY OF THE LAND--TOPOGRAPHY OF SITE--TYPE OF SOILS

CRITERION MEASURE:
MAPS SHAPE OF LOT
DRAWS TOPOGRAPHY OF SITE
KNOWS NECESSITY OF SOIL INFORMATION (PERCOLATION TESTS FOR SEPTIC AND GARDENING)
KNOWS ORIENTATION OF SITE (N-S-E-W)

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Mapping lot (on paper)	I. Map basic characteristics A. Shape of lot B. Note approx. size	I. Ability to understand and use the grade on the site to the best advantage
II. Do a soil test	II. Know the soil A. Do a percolation test (for septic tank) B. Have samples of soil analyzed 1. Local county agriculture extension service 2. Near-by university	II. Become familiar with the type of soil on lot and its characteristics
III. Determine the topography of the land		

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: SITE

TASK: (No. 10) MAP INFLUENCING SITE CHARACTERISTICS

COMPETENCY: UNDERSTANDING SITE CHARACTERISTICS IN ORDER TO FIND BEST LOCATION FOR DWELLING

CRITERION MEASURE:
NOTES DIRECTION OF PREVAILING WINDS
NOTES DIRECTION OF SUN (SOUTH)
MAPS OUTSTANDING VEGETATION (LARGE DECIDUOUS TREES, FERNS, WILDFLOWERS, CLEARINGS, PINE STANDS)
MAPS OUTSTANDING WATER RESOURCES

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Draw a map on 8-1/2 x 11" paper	I. Understand climate characteristics A. Locate direction of prevailing winds 1. Summer winds 2. Winter winds B. Note direction of south	I. Deal with site characteristics that cannot be changed
	II. Understand physical resources A. Outstanding vegetation 1. Large trees 2. Ferns 3. Wildflowers 4. Clearings 5. Pine stands 6. Other B. Location of water on site 1. Creeks or streams 2. Ponds or lakes 3. Springs 4. Marshes or bogs	II. Use natural characteristics to their best advantages

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: SITE

TASK: (No. 11) LIST ZONING REGULATIONS WHICH AFFECT HOUSE CONSTRUCTION

COMPETENCY: DETERMINE THE EFFECT OF BUILDING CODES AND ZONING REGULATIONS ON HOUSE DESIGN

CRITERION MEASURE: USES REQUIREMENTS FOR SANITATION BY HEALTH DEPT. (WATER, WASTE DISPOSAL)
LISTS LOT RESTRICTIONS (DWELLING SIZE, SETBACK FROM ROAD AND OTHER HOUSES, LIMIT TO NUMBER OF DWELLINGS)

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Requirements for sanitation	I. Regulations for health dept. A. Inspections 1. Well 2. Septic tank and drain field 3. Others B. Limitations 1. Distance of septic tank and drain field from house (or distance and depth of outhouse) 2. Depth of well--quality of water	I. Understand how regulations will affect where house is put on lot and health regulations which affect building costs and procedures
II. Zoning restrictions	II. Zoning affecting dwelling A. Type of dwelling 1. Size 2. Setback from road or other homes 3. No. of family units/acre	

REFERENCES (see Bibliography for complete information)

Major Texts:

Other Homes and Garbage is a general reference for energy efficient building. It is included here as a major reference for its section on site planning.

Low Cost Energy Efficient Shelter
See previous description.

Your Engineered House is a design-build book with valuable information. Students should be advised to be wary of some suggestions about construction methods which may be overly labor intensive and nonproductive.

The Owner-Built Home
See previous description.

AUTHORITIES/BUBBLE DIAGRAMING
(SITE RELATIONSHIPS)

AUTHORITIES/BUBBLE DIAGRAMING (Site Relationships)

The intent of this segment is to familiarize students with the authorities who have legal control over their project, those who have subtle control and those who may be helpful in the process of building.

Authorities with legal jurisdiction over students' building projects include local and state building codes, national electric codes and county health requirements. Local planning and zoning requirements may influence types and sizes of homes built in a certain area. Encourage students to become aware of other applicable codes for their region (such as flood plan, erosion control).

Electrical, plumbing and health codes are set up to insure the safety and health of the present and potential future residents of a house. If this type of work is done by subcontractors, students should know the local codes because they should have the work inspected prior to final payment for the job.

Some of the available literature concentrates on ways to avoid or fool the building inspector. He/She should be considered a resource rather than a problem until proven otherwise. Inspectors are most often people with considerable building experience and can often be enlisted to help work out problems rather than cause them. In the case of structural problems, finding an architect and/or engineer to approve a new idea will often relieve the inspector of his/her responsibility.

Bankers have the subtle control over the design of a house, and students should be aware of this. It is advisable to poll local loan offices for their prejudices and requirements. If students are dependent upon a bank for money, it will probably affect the type of houses they can build and the systems that go in the house.

Other authorities who may have control in your area include appearance committees, zoning boards and other land owners.

Authorities who may be helpful are architects, engineers, subcontractors and materials dealers. They are helpful resources when students encounter problems with structures, systems, and materials.

Bubble Diagraming

The student, having completed a program of spaces, site analysis and introductory course work, is ready to begin design. Bubble diagraming is a design technique which will allow quick examination of many ideas and solutions to the multitude of problems which must be considered in a house design. Note that part of the importance of the bubbles is that they are not rooms but symbols of rooms and less subject to preconceptions. The goal is to forestall, as long as possible, making the bubbles into a plan and losing flexibility to try new ideas.

Bubble diagraming exercises are broken into two areas of emphasis. In practice it is difficult to separate them, but the first week's emphasis is

on site relationships. The second is on room relationships. Many things have to be considered at once. Begin with site relationship questions.

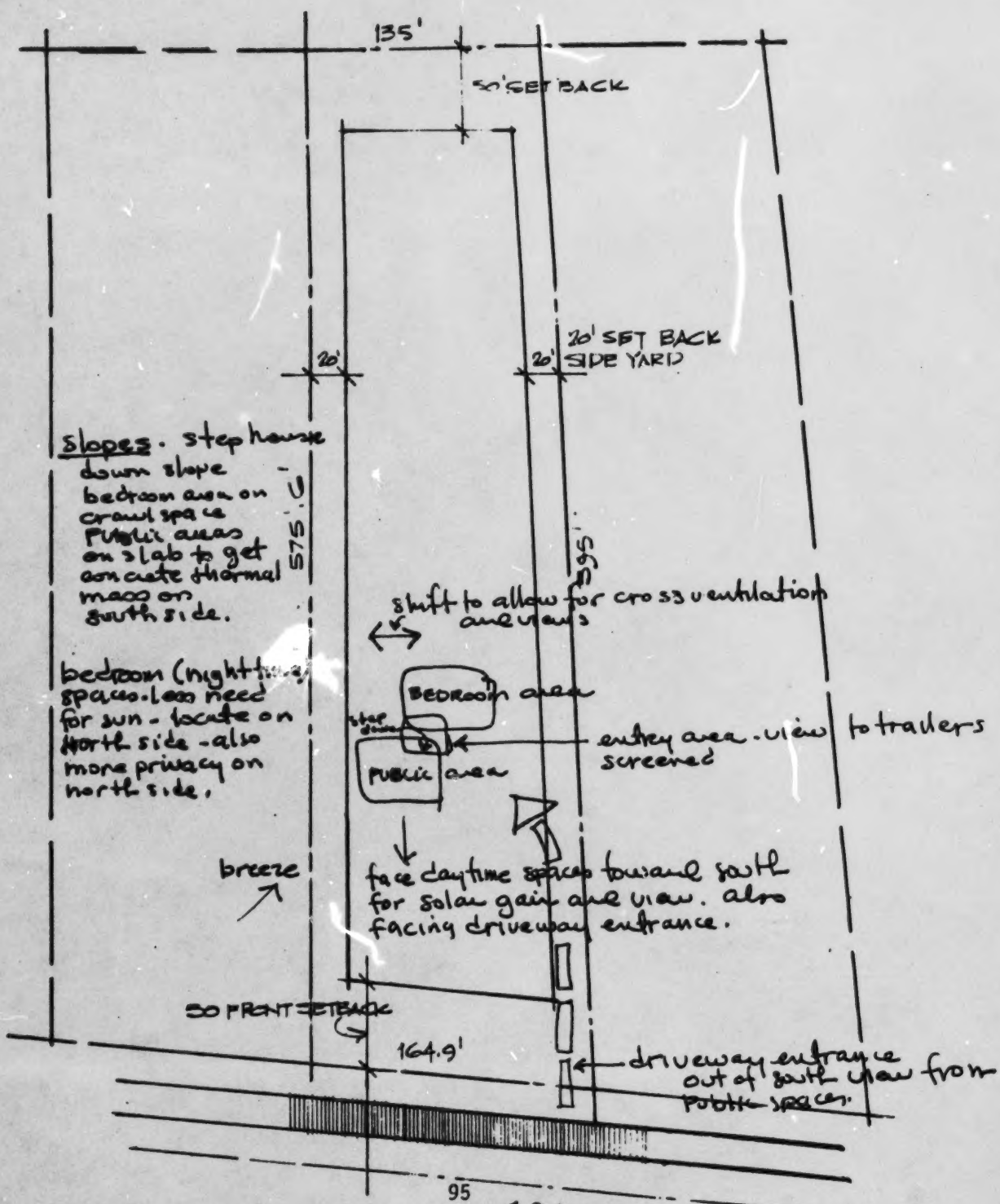
1. Which rooms relate to which views?
2. Which rooms relate to which sun orientation?
3. Which rooms relate to which driveway access?
4. Which rooms relate to which site noise?
5. Which rooms relate to which breeze?
6. Which rooms relate to which slope?

Emphasize importance of not getting into actual design solutions. These relationships are probably best studied working with or directly over the site analysis study previously completed. Tracing paper is the best medium for drawing. Drawing supply stores (ones that cater to architects and engineers) have inexpensive tracing paper called "trash."

HANDOUT #11

Bubble Diagraming site relationships

CASE HOUSE
Small Pond Lane
Fairmont, IL


135'
50' SET BACK
20'
20'
20' SET BACK SIDE YARD
Slopes. step house down slope - bedroom area on crawl space Public areas on slab to get concrete thermal mass on south side.
575'
595'
shift to allow for cross ventilation and views
bedroom (night time) spaces. Less need for sun - locate on North side - also more privacy on north side.
BEDROOM area
entry area
PUBLIC area
entry area - view screened
to trailers
breeze
face daytime spaces toward south for solar gain and view. also facing driveway entrance.
50 FRONT SETBACK
164.9'
driveway entrance out of south view from public spaces.

PAGES 97-98 "OFFER TO PURCHASE AND CONTRACT" REMOVED
DUE TO COPYRIGHT RESTRICTIONS.

Handout #13

SAMPLE

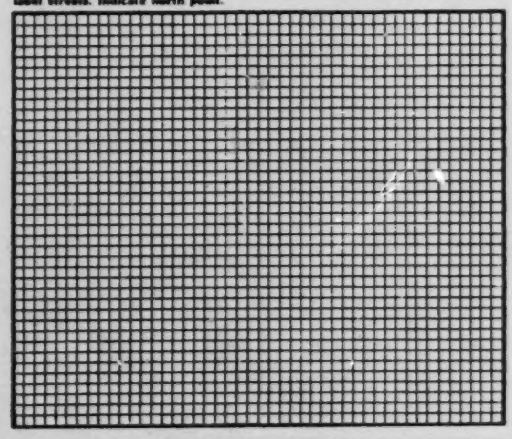
COUNTY OF
INSPECTION DEPARTMENT
Application for Building Permit

AREA	FLOOD HAZARD AREA		ZONING	TOWNSHIP	
DATE	YES	NO	ROAD	TAX MAP NO.	PARCEL

BOARD OF ADJUSTMENT YES NO DATE _____ CASE NO. _____

	ADDRESS	SUBDIVISION	LOT NO.	BLOCK SECTION
Land Owner				
Building Owner		License No.	Phone No.	Lot Recorded: Book / Page
General Contractor		License No.	Phone No.	Lot Recorded: Book / Page
Plumbing Contractor		License No.	Phone No.	Lot Mapped In: Book / Page
Heating-Air Conditioning		License No.	Phone No.	Corner Lot: YES / NO
Electrical Contractor		License No.	Phone No.	Mos. Completion
Other		License No.	Phone No.	Number: Rooms / Baths
Electrical Service		Phone No.	Location of Co.	Power Ticket #

PLOT PLAN: Draw accurately, from survey if possible. Show dimensions of lot and buildings. Locate buildings by dimensions from property lines. Show and label streets. Indicate north point.



PRINCIPAL TYPE OF FRAME
- ( ) Masonry
- ( ) Wood
- ( ) Structural Steel
- ( ) Reinforced Concrete
- ( ) Other _____

TYPE OF WORK
- ( ) New Construction
- ( ) Additions
- ( ) Alterations
- ( ) Repairs
- ( ) Demolition
- ( ) Relocation
- ( ) Other _____

RESIDENTIAL
- ( ) Single Family
- ( ) Multi-Family
- ( ) Number Units _____
- ( ) Comm. Residential
- ( ) Garage or Carport
- ( ) Accessory Building
- ( ) Utility Building
- ( ) Fence
- ( ) Other (specify) _____

EXISTING USE
_____
Other _____

OFF STREET PARKING: YES / NO

UTILITIES
- ( ) Municipal water
- ( ) Municipal sewer
- ( ) Private water
- ( ) Private sewer

MECHANICAL
- ( ) Type heat: _____
- ( ) Fuel: _____
- ( ) Central A/C: _____
- ( ) Heated floor area sq. ft. _____
- ( ) Unheated floor area _____
- ( ) Elevators? _____

NONRESIDENTIAL
- ( ) Mercantile
- ( ) Office
- ( ) Institutional
- ( ) Service/Repair
- ( ) Industrial
- ( ) Storage
- ( ) Assembly
- ( ) Church
- ( ) Sign
- ( ) Other

DIMENSIONS
- Number of stories _____
- Total floor area, sq. ft. _____
- Total land area, sq. ft. _____
- Front yard depth: _____
- Side yard depth: _____
- Total, both side yards: _____
- Back yard depth: _____

COST OF IMPROVEMENT

1. General construction	$ _____	Rec. # _____
2. Electrical	$ _____	Rec. # _____
3. Plumbing	$ _____	Rec. # _____
4. Heating/air cond.	$ _____	Rec. # _____
5. Other _____	$ _____	Rec. # _____

MOBILE HOME INFORMATION
- MAKE: _____
- SERIAL NO: _____
- UL/HUD NO: _____
- YEAR: _____
- MODEL: _____

IMPROVEMENT PERMIT NO. _____ DATE: _____
ISSUING OFFICER: _____
CERTIFICATION OF COMPLETION NO: _____ DATE: _____
APPROVING OFFICER: _____

CERTIFICATE OF OCCUPANCY
- NUMBER: _____
- DATE: _____
- APPROVED BY: _____

Applicant understands that this application becomes a permit when site and footing inspections are made an approved. The applicant agrees to comply with all building regulations and other laws applicable to the use of the structure and facilities referred to herein.

Signature of Applicant _____ Address _____ Date _____

DIRECTIONS: _____

COMMENTS: _____

Application approved by _____ Permit Number 20001 Date permit issued _____

White: FILE COPY Yellow: APPLICANT COPY Pink: FIELD COPY

INSPECTION CHECK LIST

BLD GROUND WORK

Date _____ Inspector _____

ROUGH-IN INSPECTION

Date _____ Inspector _____

PERIOD INSPECTION

Date _____ Inspector _____

CONDITIONAL SERVICE

Date _____ Inspector _____

FINAL INSPECTION

Date _____ Inspector _____

I certify that all inspections listed above have been made and approved:

Date _____ Inspector _____

Approval subject to the following conditions:

PLOT PLAN	INSPECTOR'S APPROVAL	DATE	COMMENTS:
SITE INSPECTION ZONING			
EXCAVATION—FOOTING			
FOUNDATION WALLS			
SLAB			
FLOOR FRAMING			
PLUMBING GROUND WORK			
PLUMBING ROUGH-IN			
HEATING & AIR CONDITIONING ROUGH-IN			
ELECTRICAL ROUGH-IN			
COMPLETION OF SEPTIC TANK SYSTEM			
FRAMING			
FIRE PROOFING			
PLUMBING FINAL			
HEATING & AIR CONDITIONING FINAL			
ELECTRICAL FINAL			
R I INSULATION			
FINAL INSULATION			
OFF STREET PARKING			104
DRIVEWAY ENTRANCE			
BUILDING FINAL			
BUILDING WATER SERVICE			

Date _____ Inspector _____

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: AUTHORITIES/ BUBBLE DIAGRAM

TASK: (No. 12) USE A BUBBLE DIAGRAM TO DEVELOP WORKING HOME SYSTEM

COMPETENCY: DEVELOP A ROUGH HOUSE PLAN THAT DEALS WITH LOCATION AND SIZE OF ROOMS
DEVELOPMENT OF TRAFFIC FLOW AND ORIENTATION OF HOUSE ON SITE

CRITERION MEASURE: DEVELOPS A DRAWN PATTERN FOR ROOMS--TYPES OF ROOMS, THEIR RELATIVE IMPORTANCE AND ORIENTATION TO EACH OTHER
DEVELOPS ROUGH SKETCHES OF WHOLE HOUSE PLAN (USING BUBBLES)
ORIENTS HOUSE PLANS OVER SITE MAP

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Sketch layout of rooms	I. Organize spaces A. Location of spaces relative to others B. Spaces of primary importance C. Link between rooms (traffic flow) D. Develop basic layout for house	I. Use bubble diagrams to organize train of thought
II. Organize house plan in relation to site	II. Layout house on site A. Use tracing paper to overlay house plan on site B. Understand areas that may need grading for house C. Recognize vegetation which may affect location of house D. Locate any paths for vehicles	II. Understand how site will influence house plans

REFERENCES (see Bibliography for complete information)

Low Cost Energy Efficient Shelter

Your Energy Efficient House

Your Engineered House

From the Ground Up

The Owner Built Home
See previous description.

North Carolina Uniform Residential Code is the basic state building code for residential projects. It is a valuable guide as to what is allowed and contains many structural tables.

STRUCTURAL SYSTEMS/BUBBLE DIAGRAMING
(ROOM RELATIONSHIPS)

STRUCTURAL SYSTEMS/BUBBLE DIAGRAMING (Room Relationships)

The purpose of this section is to expose the student to basic structural systems and materials, to enable them to reasonably select an approach to the structure of their house based on their skills, interests, design ideas and site conditions.

Basic Structural Design

Though there are many structural systems which are appropriate to residential building and, based on class interests, should be discussed, the majority of homes, including owner built ones, use basic wood framing systems.

Floor Systems

In addition to the economy of construction of slab or grade floors, the additional thermal mass provided by this approach should be seriously considered for relatively flat sites. Care should be taken to insulate under and on the ends of the slab so that stored BTUs do not escape.

Wood framed floor systems normally employ wood joists 16" or 24" on center. Though 2 x 10 are traditionally used, careful analysis of lumber costs and span tables may indicate using joists as small as 2 x 6. Built-up wood trusses are also made for houses. They have the ability to extend the span possible and have provision for ducts and wiring to run within them.

Wall Systems

1. Post and Beam

This system is made up of standard frames, columns (posts) and beams forming a grid work which transfers loads to the ground without relying on wall construction for support.

It may be used to minimize the effect of foundation work on the site or to make usable a site which is otherwise difficult (i.e., steep slope or natural features which cannot or should not be altered).

Post and beam construction gives absolute freedom in locating walls as they are not required for structural support.

It is possible to erect the frame and build a roof before filling in walls or floors which may be an advantage in wet or hot weather.

Foundation work probably will be less expensive in post and beam construction.

Good quality structural materials for columns and beams are difficult to obtain in most areas.

Insulation requirements may result in duplication of structural systems (i.e., structural frame plus 2 x 6 walls) or outside walls.

This type of construction is considered more difficult to build, particularly for an unexperienced builder.

2. Bearing Wall Construction

Bearing wall construction is the industry's standard approach to building houses. The system is put together with structural pieces (trusses, rafters, joists, studs, etc.) on 16" or 24" centers or continuous foundation walls.

The foundation for a bearing wall system is more expensive and more destructive of site environment than the post and beam system. (Note: Trees are often lost not only to root cutting loss but to change in pH of the soil by concrete placement.)

The bearing wall system lacks the structural "clarity" of the post and beam system.

Roof Systems

Residential roof construction is generally accomplished with wood rafters or gang nail manufactured trusses. Contractors generally consider trusses less expensive to use. Rafters offer the advantage of more open attic space in conventional construction.

Domes

Geodesic domes theoretically represent an ideal system for the owner-builder as the system minimizes materials (sphere maximizes interior volume for exterior perimeter, heat loss, etc., and according to some texts requires less time to erect. The space available cannot necessarily be used efficiently, and the rising heat requires special attention to be recirculated to the "people areas" of the dome. This information should be tempered with the apparent fact that domes, at least on the residential scale, are virtually impossible to seal against water penetration (see "Smart but Not Wise" in Shelter).

Basic Structural Materials

This section includes discussion of characteristics of basic house building structural materials. For sizing, structural members charts in the N.C. Code, Simplified Engineering for Architects and Engineers, and from The Ground Up, and other sources are usually adequate. Any table should be checked to make certain the actual dimensions for which the table is calculated are the same size that is available now, as structural lumber sizes have been shrinking. Both From the Ground Up and Simplified Engineering for Architects and Builders offer basic structural theory for the student who wishes to go beyond the systems which are available through the tables. (Note: Floor joists spans in N.C. Code tables are lenient and will probably result in bouncy floors near the upper limit.)

It is important to consider the characteristics of materials and how these affect their uses.

Concrete

Concrete has excellent compressive strength which makes it most useful for footings and foundation walls. Its lack of tensile strength can be made up for by reinforcing it with steel. Concrete has excellent thermal mass characteristics if used inside insulation but must be properly used to be effective. Concrete is generally bought by the cubic yard.

Wood

Structural wood is generally used for framing and occasionally (when pressure treated) for foundations. It is important to rely on stress tables to insure proper structural characteristics according to the type and structural use of the wood available in the area the builder lives.

Masonry

Masonry has good thermal mass potential if used inside insulation. It requires little maintenance and is similar to concrete except that it has little compressive strength. Masonry is used for foundation and house walls, floors and retaining walls.

Plywood

Plywood is generally used for sheathing and bracing. There are varieties of plywood according to use. Students should be particularly careful to buy specific exterior grade where plywood will be subject to water.

Steel

Steel structural materials are generally limited to flitch plates, columns and beams unless the student is involved with industrial building structures.

Fasteners

Fastening materials include nails, screws, bolts and glue (including mortar). Types and coatings vary according to the materials to be fastened.

Bubble Diagraming

The bubble diagraming effort in the last section concentrated on site relationships. This section will look into room relationships. Consider these kinds of questions.

1. How do rooms relate to front entry?
2. How do rooms relate to rear entry?
3. What are the relationships of "public areas" and "private areas"?
4. How do various spaces (i.e., kitchen and dining room, dining room and living room) connect to each other (i.e., same room, connected by a door, down the hall, same room-different floor, or ceiling, or wall material)?

5. Where does the family eat its meals?
6. Where do the kids play during the day?
7. Where do the teenagers entertain their friends?
8. How do the groceries get into the house?
9. What do guests see when they enter?
10. How will quiet areas be separated from noisy ones?

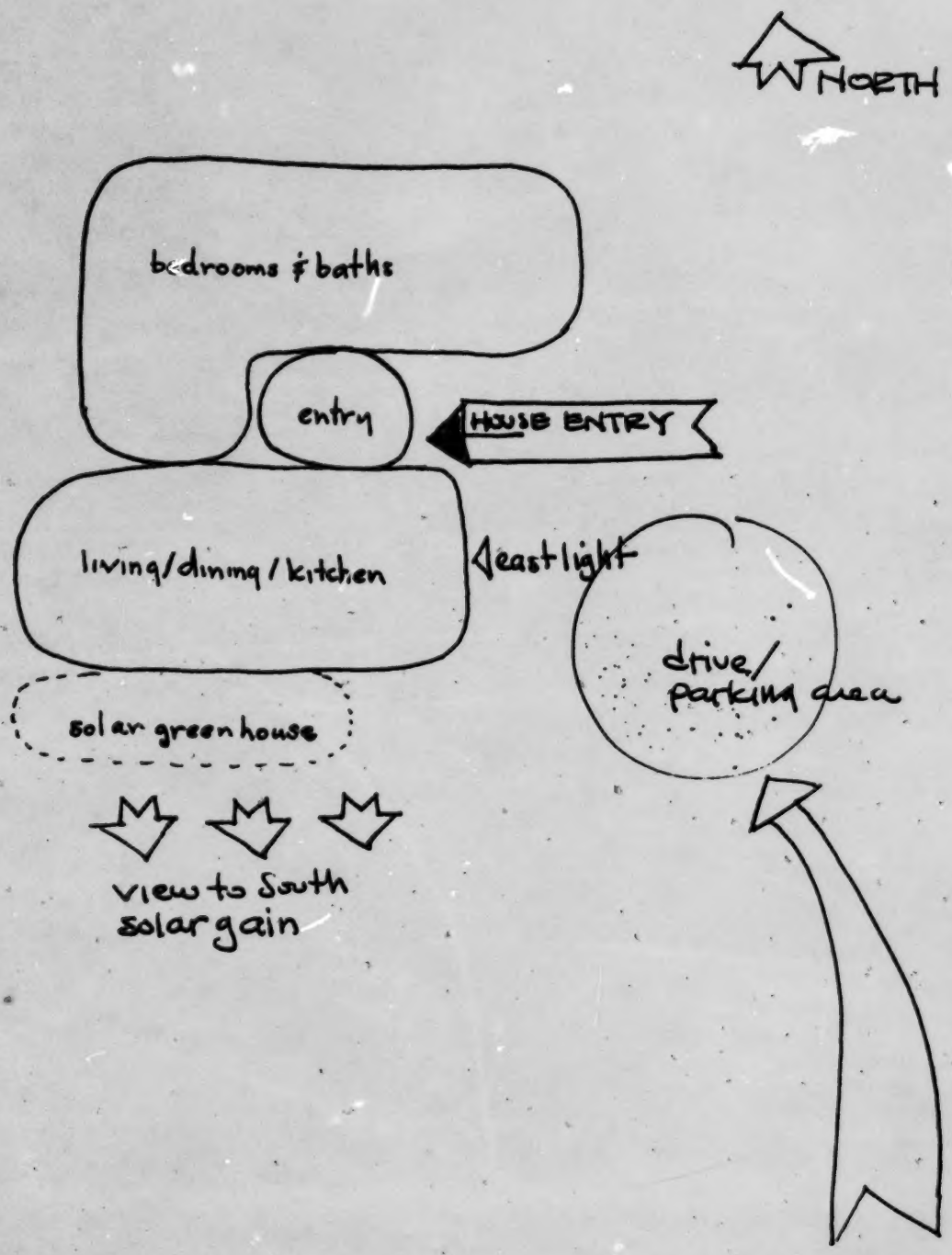
Questions, problems and ideas generated by this discussion and the previous week's site relationships study should begin to direct the student towards an actual design solution for his/her house.

From these ideas the student can proceed to develop formal plans and elevation views for the house. All emphasis to this point has been on plan studies and elevation studies. What the house looks like should be studied, probably overlaying actual scale drawings.

HANDOUT #14

BUBBLE DIAGRAM
SPATIAL RELATIONSHIPS

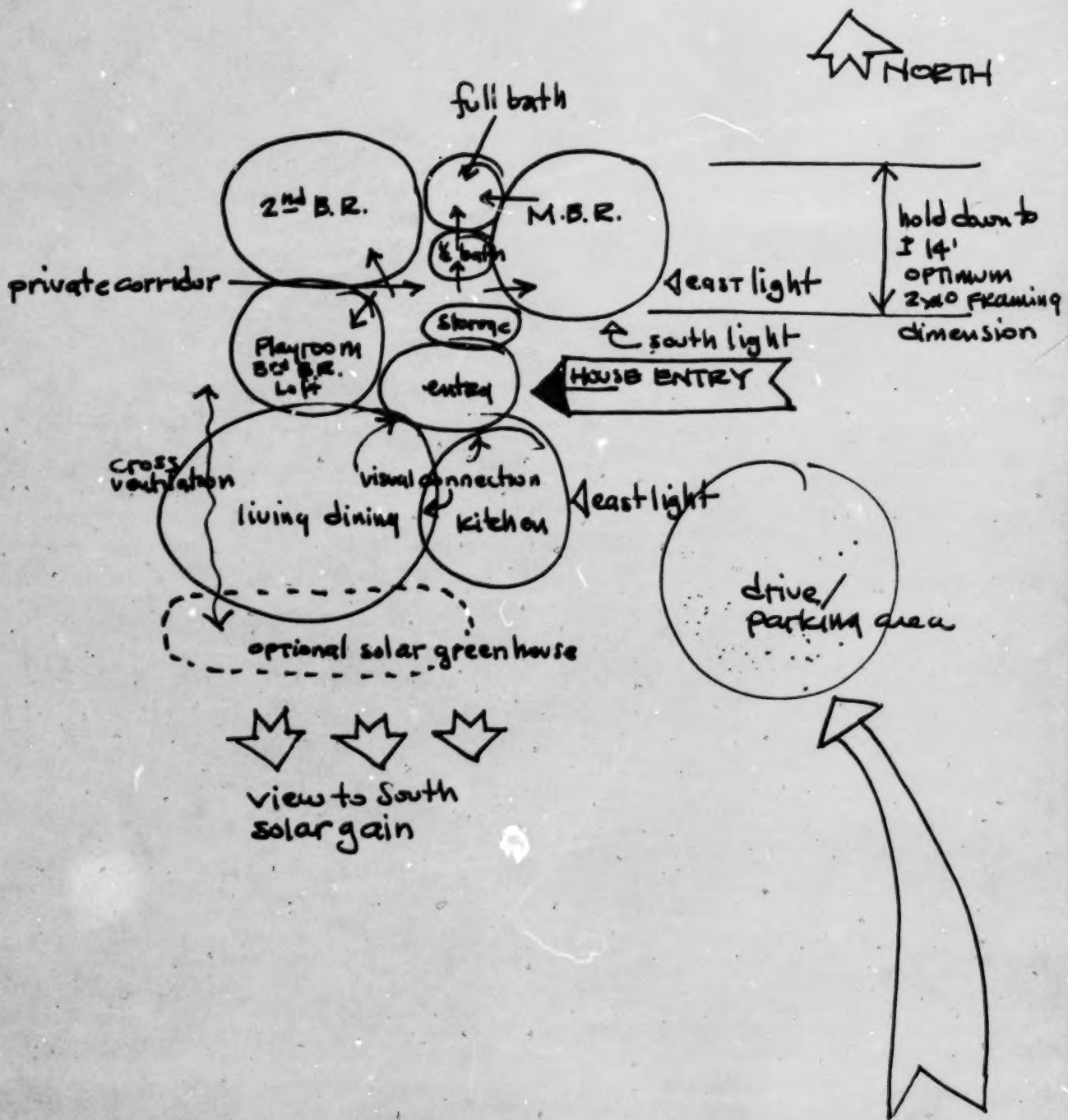
Case House
Small Pond Lane
Piedmont, N.C.



HANDOUT #15

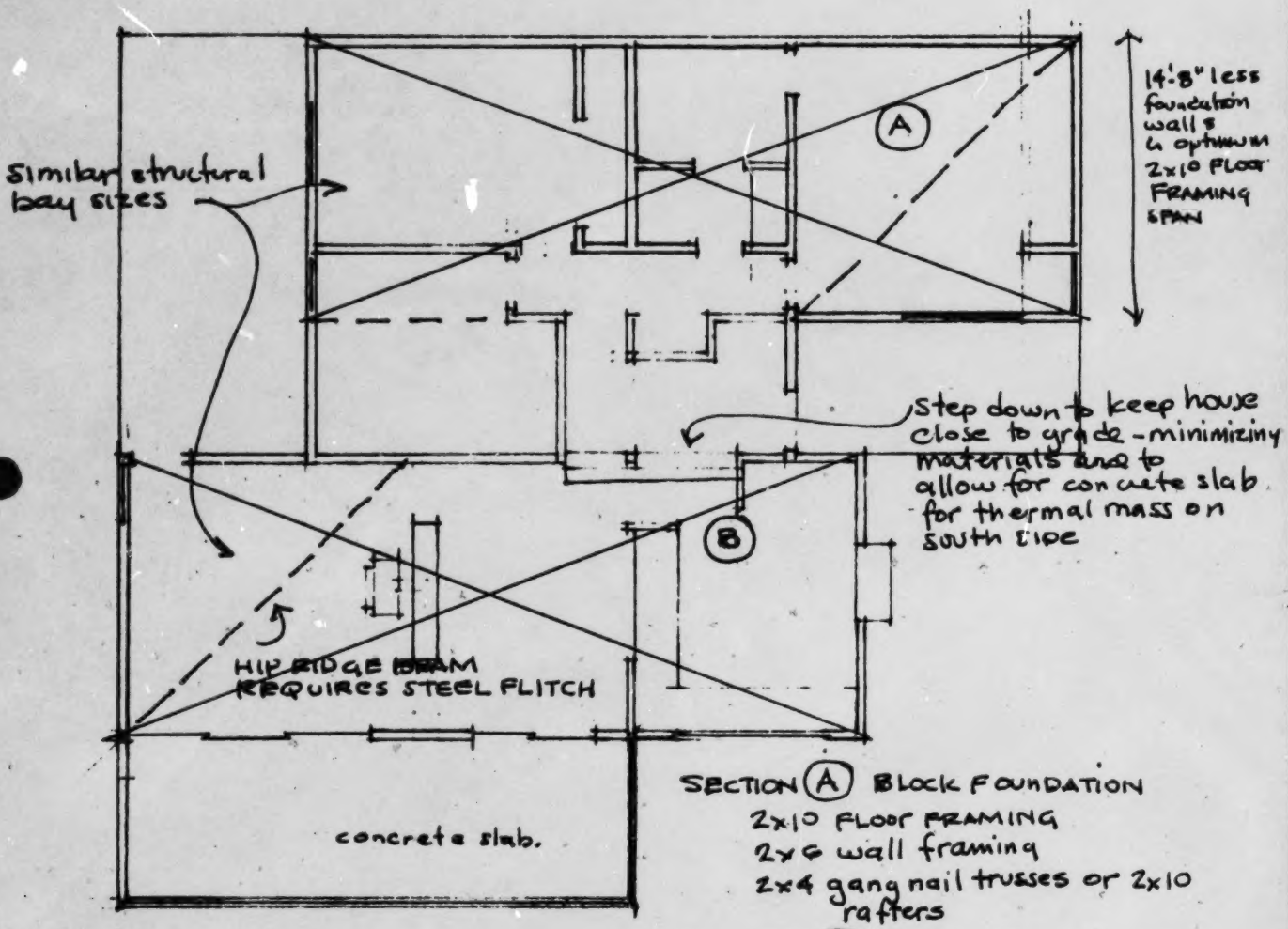
BUBBLE DIAGRAM ROOM RELATIONSHIPS

Case House
Small Pond Lane
Piedmont, N.C.



HANDOUT #16

Preliminary STRUCTURAL DESIGN - Case House


Similar structural bay sizes
14'-8" less foundation walls is optimum 2x10 FLOOR FRAMING SPAN
A
B
step down to keep house close to grade - minimizing materials and to allow for concrete slab for thermal mass on south side
HIP RIDGE BEAM REQUIRES STEEL FLITCH
concrete slab.

SECTION (A) BLOCK FOUNDATION
2x10 FLOOR FRAMING
2x6 wall framing
2x4 gang nail trusses or 2x10 rafters

SECTION (B) similiar dimensions concrete slab on grade, roof section over L.R. / D.R. has high ceiling - 2x10 rafters. section over kitchen trusses.

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: STRUCTURE/ BUBBLE DIAGRAMI

TASK: (No. 13) DRAW FORMAL HOUSE PLANS TO SCALE

COMPETENCY: DEFINE DIMENSIONS OF HOUSE AND THE ROOMS WITHIN

CRITERION MEASURE:
- DEFINES LAYOUT OF ROOMS
- DEFINES SIZE OF ROOMS
- DEFINES EXTERIOR LIMITS OF HOME
- USES BASIC LAYOUT TOOLS AND MEASURES TO SCALE
- DETERMINES ORIENTATION OF LOT ON SITE

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Draw formal plans to scale	I. Layout house on graph paper A. Determine scale (usually 1/4"=1') B. Layout house plans on paper 1. Mark dimensions on paper 2. Leave space for walls 3. Note exterior dimensions for house 4. Use bubble diagrams to assist in layout	I. To define exact dimensions of house to use as working drawings
II. Formulate the house plan with reference to site plan	II. Overlay graph paper for house plan on site plan A. Mark north arrow on house plans B. Note any outstanding site characteristics C. Dimension house and mark interior spaces D. Draw second floor (if any) on separate sheet 1. Overlay sheet for second floor on first 2. Dimension second floor	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: STRUCTURE/ BUBBLE DIAGRAMING

TASK: (No. 14) LIST BASIC STRUCTURAL MATERIALS AND THEIR RELATIVE ECONOMIC PRIORITIES

COMPETENCY: DETERMINE THE TYPES OF MATERIALS HOUSE WILL BE MADE OF

CRITERION MEASURE:
DETERMINES BASIC MATERIALS TO BE USED
UNDERSTANDS ECONOMICS OF MATERIALS (COST, AVAILABILITY, DURABILITY, AESTHETICS)
PERSONAL ABILITY TO HANDLE MATERIALS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Understand basic materials	I. List materials A. Footings and foundations B. Floors C. Walls D. Roof E. Roofing F. Roofing materials G. Insulation H. Windows and doors	I. To gain a better understanding of the types and cost of materials needed
II. Economics	II. List for each material: A. Cost 1. Initial cost a) Material b) Insulation 2. Life cycle costs B. Availability 1. Local availability 2. Special order 3. Recycling C. Durability 1. Appropriate for climate 2. Need for long-range maintenance D. Aesthetics--Is it personally pleasing to you?	II. To compare economic and other factors in material selection

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
III. Personal capabilities	III. Ability to handle materials A. Strength (Can you handle those materials by yourself?) B. Friends C. Local labor--high school or college summer workers	III. Recognizing the need for help of some sort (there are times you will need help)

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: STRUCTURE/ BUBBLE DIAGRAMING

TASK: (No. 15) DETERMINE NEED FOR FOUNDATIONS, FOOTINGS, AND PIERS

COMPETENCY: ABILITY TO RECOGNIZE VARIOUS TYPES OF FOOTINGS, FOUNDATION WALLS AND PIERS AND TO DETERMINE THE AMOUNT OF MATERIALS NECESSARY FOR CONSTRUCTION OF SUCH

CRITERION MEASURE: DETERMINES THE TYPE OF FOOTINGS, FOUNDATIONS AND PIERS (OR COLUMNS) THAT ARE MOST APPROPRIATE FOR HOUSE
CALCULATES AMOUNT OF MATERIALS NECESSARY TO CONSTRUCT FOOTINGS, FOUNDATION AND PIERS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Determine type of footings and foundation house will have	I. Types of footings and foundations A. Footings 1. Continuous footings 2. Spot footings (for piers or posts) 3. Neat beam trench excavation (slab on grade with stiffener beams) B. Foundations 1. Walls 2. Misc. stair, step and stoop	I. Understand what sort of footings/foundation is most appropriate for individual house design and site
II. Identify methods of calculating required footings and foundations	II. Materials A. Concrete (calculated by the cubic yard if poured) 1. Structural concrete (footings and foundations) 2. Lightweight concrete (slabs and beams) 3. Precast a) Blocks (various sizes) b) Benches c) Steps d) Prestressed	II. Recognize structural limitations of footings and foundation materials

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
	II. (Continued) B. Wood posts--for post and beam construction	
III. Determine amount of materials needed	III. Total amount A. Concrete 1. Cubic yard (see handout) 2. Block and mortar (see handout) 3. No. of steps 4. No. of prestressed beams B. Wood 1. Size of posts 2. No. of posts	III. Understand amount and types of materials necessary for the footings/ foundation.
	IV. Grading for site	
	V. Also make considerations for ventilation if a crawlspace is under the house.	

REFERENCES

North Carolina Uniform Residential Code

Your Energy Efficient House

From the Ground Up
See previous description.

Simplified Engineering for Architects and Builders is a basic structural manual. It includes very readable sections on timber construction in addition to tables.

Shelter includes an article by Lloyd Kahn entitled "Smart but Not Wise," which is valuable reading for students considering construction of a dome.

Domebook 2 is the basic dome construction handbook.

FINISH MATERIALS

FINISH MATERIALS

The purpose of this class is to discuss and make the student aware of the options which are available to him/her in the choice of finish materials and what criteria are available for judging these choices.

Finishing materials are important for several reasons. The type of finish materials the individual chooses will affect the atmosphere, maintenance, cost, thermal efficiency and the amount of infiltration of a house. Proper siding, roofing and flooring can add to the thermal mass of a home. R-values of materials should be considered when buying finish materials. Economy is an important factor to consider also. Initial cost (materials and labor), maintenance costs, as well as durability of materials must be discussed. The best materials for a certain job will not always be the least expensive, but the cost of a material may not always indicate that it is of the highest quality or that it is most appropriate for a particular situation.

Exterior Materials

Foundation walls must be strong and compatible with siding, roofing and environment. Materials for the foundation must also be allowed for on the foundation plans, as sizes of materials used will affect the size of footings. Discuss concrete block (plain and decorative), brick and stone and pressure treated wood.

Siding represents the largest exterior surface of the building, so the type of material it is covered with will have a significant effect on the cost of materials and the heat losses of the house. Choices include brick, stone, wood (board and sheets), plywood and masonite.

The actual "R" value of specific siding materials does vary but probably not significantly. A more important consideration is how to control infiltration of air and water with the entire wall construction system and the maintenance of the system once complete.

Roofing materials to be discussed run in three categories: 1) shingles (asphalt and cedar, 2) roll roofing, and 3) sheet roofing (galvanized, aluminum, asphalt, and fiberglass). Each of these different materials is appropriate for certain types of roofs, depending on the climate, type of roof, slope of the roof, and the visual effect of the house. Discuss installation difficulties of roofing materials, their life cycle costs, as well as energy factors and the visual appeal.

Interior Materials

The type of material used for the floor directly affects the subfloor needed. Masonry floors are most effective on a masonry (cement) subfloor, particularly for bathrooms where the floor will come in contact with water. Masonry floors (ceramic tile, brick, quarry tile) also add thermal mass to a home. Wood floors are traditional and relatively a good buy. Individuals

must consider tongue and groove pine floor which probably will cost less money. Resilient flooring in sheets and tiles should be considered, particularly where there is potential for moisture. Costs range up to that of hardwood floors. Carpeting is another flooring option. Other than its obvious visual appeal, it has acoustical and, with urethane or rubber pad, perhaps a bit more insulation value than other floor choices. Carpet life is significantly less than other types of flooring.

Interior wall finishes include sheetrock, paneling, wood and masonry. Class discussion of these materials should include thermal mass of materials, ease of installation, cost and aesthetics.

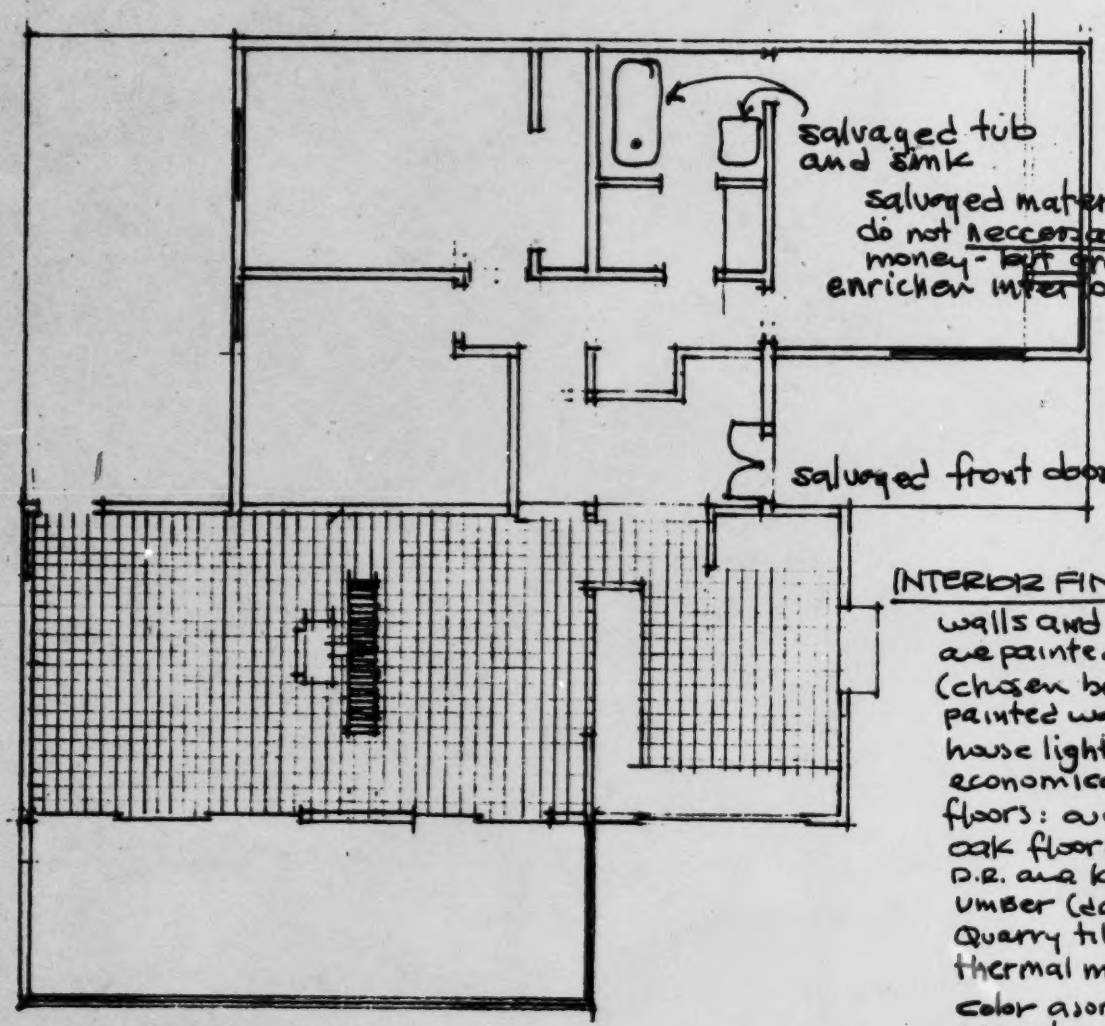
Ceiling materials such as ceiling tiles and sheetrock should be considered as well as using the second story floor for a ceiling in houses where there are two floors. This can be done with beams and boards (tongue and groove).

HANDOUT #17

FINISHES CASE HOUSE

EXTERIOR FINISHES

SIDING 1x6 Pressure treated pine clapboard. (economical no finish required)
windows, sliding glass doors are aluminum (economical - some heat loss through jambs)
Roofing 235# Asphalt shingles


salvaged tub and sink
salvaged materials do not necessarily save money - but greatly enriches interior finishes.
salvaged front door

INTERIOR FINISHES

walls and ceilings are painted sheetrock (chosen because painted walls keep house light and economical
floors: over crawlspace oak floors, in L.R. D.R. and kitchen umber (dark brown) Quarry tile adds to thermal mass, dark color absorbs more heat greenhouse has concrete floor.
wall behind fireplace is painted stucco.
cabinets are natural finish birch veneer plywood.
Bathrooms have unglazed ceramic tile

INSULATION

FLOORS: R-19 FIBERGLASS BATTS crawl space
1½" STYROFOAM UNDER SLAB
walls: R-19 BATTS with stapled 6 mil vapor barrier
ceilings: R-30 batts or blown Class A cellulose over attic space, R 30 (8" batts) in raftered space - MAINTAIN AIR WAY OVER
venting: continuous soffit vents and continuous ridge vents

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 16) CHOOSE THE STYLE OF ROOF COMPATIBLE WITH HOUSE PLANS AND DETERMINE AMOUNT OF VENTILATION NEEDED FOR CEILING AREA

COMPETENCY: RECOGNIZE VARIOUS TYPES OF ROOFS, THE CONSTRUCTION TECHNIQUES AND HOW TO CALCULATE THE AMOUNT OF VENTILATION NEEDED FOR ROOF

CRITERION MEASURE:
UNDERSTANDS DIFFERENT ROOF CONSTRUCTIONS
KNOWS PROBLEMS AND ADVANTAGES OF EACH STYLE
CHOOSES THE STYLE WHICH BEST FITS PARTICULAR PURPOSES, SITE AND CLIMATE
RECOGNIZES BASIC FRAMING COMPONENTS INVOLVED IN CONSTRUCTING A ROOF
UNDERSTANDS NEED FOR VENTILATION AND DESCRIBES THE VENTILATION TO BE USED IN THE ROOF STYLE CHOSEI

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Recognize different types of roofs	I. Styles of roofs A. Gable B. Flat C. Shed D. Hip E. A-Frame F. Gambrel G. Mansard H. Butterfly	I. Understanding the options to choose from when constructing a roof
II. Recognize various framing techniques for roof	II. Framing members A. Trusses 1. W-type truss 2. King post truss 3. Scissors truss 4. Raised chord truss 5. Saw toothed truss 6. 1-1/2 story frame truss 7. Flat truss 8. Bowstring truss 9. Utility truss B. Ridge board C. Rafters D. Gable end studs E. Lookout F. Gussets 1. Make trusses more stable 2. Positioned over joints	II. Knowledge of how the roof is constructed

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
III. Determining ventilation needed	III. Ventilation A. Reasons for vents 1. To prevent moisture condensation in attic 2. To keep insulation from becoming wet and ineffective B. Amount of ventilation needed 1. Area of ventilation opening needed is equal to 1/300th of the total ceiling area 2. Eave vents can help lower this figure C. Types of ventilators 1. Gable vents 2. Wind turbines 3. Eave vents	III. Understanding why attic ventilation is necessary and how it works

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 17) LIST TYPES OF FINISH MATERIALS FOR HOUSE

COMPETENCY: AWARENESS OF VARIETY OF FINISH MATERIALS FOR HOUSE, THEIR COST, AVAILABILITY, AND THE QUALITIES THEY IMPART

CRITERION MEASURE:
UNDERSTANDS QUALITIES OF CHOSEN MATERIALS
UNDERSTANDS COSTS
KNOWLEDGE AND PERSONAL ABILITY TO INSTALL MATERIALS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Select finish materials	I. Materials for various areas A. Fixtures B. Floors C. Ceiling D. Walls 1. Interior 2. Exterior E. Counters and cabinets	I. Gain an ability to work with finish materials to achieve the type of effect desired
II. List costs	II. Costs of materials and equipment A. Initial--recycling B. Maintenance	
III. Personal ability to install materials	III. Personal capabilities A. Knowledge of materials B. Time to install	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 18) MAKE A LIST OF FLOOR COVERINGS (AND THE COSTS INVOLVED) THAT WILL GO IN THE DWELLING

COMPETENCY: AWARENESS OF DIFFERENT TYPES OF FLOOR COVERINGS AND THE TYPE THAT WILL BEST SUIT HOUSE

CRITERION MEASURE:
LISTS TYPES OF FLOOR COVERINGS NEEDED IN HOUSE
CALCULATES SQUARE FOOTAGE OF FLOOR AREA TO BE SURFACED
CALCULATES COST OF MATERIALS INVOLVED

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Determine type of floor cover to be used	I. Considerations A. Wood 1. Tongue and groove board 2. Finished hardwood B. Masonry 1. Tile 2. Brick C. Linoleum 1. Tile 2. Sheet D. Carpeting E. Cement	I. To become aware of various choices in floor coverings
II. Find square footage of floor area to be covered	II. Calculate area (length x width). Include waste factors or roof widths in calculations.	II. Determine most efficient use of floor covering for area
III. Calculate cost of materials involved	III. Cost A. Materials (usually by the square foot) B. Labor (installation and finishing) C. Maintenance D. Lifetime E. Weight (may determine size of floor joists)	III. Determine the cost of a durable floor

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
	III. (Continued) F. Special preparation (some masonry floor coverings require special foundations) G. Aesthetic value	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 19) DETERMINE TYPE AND COST OF EXTERIOR WALL COVERINGS

COMPETENCY: BECOME AWARE OF CHOICES IN EXTERIOR WALL COVERINGS

CRITERION MEASURE:
KNOWS OPTIONS AVAILABLE
DETERMINES AREA TO BE COVERED
FIGURES APPROXIMATE COST

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Choose wall coverings	I. Options A. Wood products 1. Particle board 2. Hardboard 3. Plywood 4. Lumber 5. Shakes (cedar) B. Concrete 1. Blocks 2. Stucco C. Masonry 1. Brick 2. Stone D. Glass	I. Become aware of types of choices for exterior finishes
II. Calculate area of wall covering required	II. Length and width of all areas and waste factors to add	
III. Figure cost of exterior wall covering	III. Cost considerations A. Materials B. Labor C. Availability D. Aesthetic value E. Insulating qualities F. Maintenance	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 20) CEILINGS: DETERMINE AMOUNT OF MATERIALS NEEDED TO COVER CEILING

COMPETENCY: BECOME AWARE OF CEILING COVERS AND THE CHOICES AND COSTS INVOLVED IN COVERING CEILING

CRITERION MEASURE:
KNOWS TYPES OF CEILING COVERINGS
CALCULATES CEILING AREA TO BE COVERED
DETERMINES COSTS OF MATERIALS CHOSEN

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Know ceiling coverings	I. Considerations A. Plasterboard (sheetrock) 1. Hanging 2. Finishing B. Wood C. Second floor--If you have two floors on your house consider using the second story (or loft) floor as the ceiling to the first (using beams, and tongue and groove) D. Other	I. Consider the qualities that ceiling will impart to the room
II. Determine ceiling area	II. Calculate length and width for all separate parts of the ceiling that need to be covered	
III. Figure cost of ceiling job	III. Considerations A. Materials B. Labor C. Weight (load on ceiling joists) D. Special preparation (sky lights, ceiling lights, attic entrance)	

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
	III. (Continued) E. Height (ceiling heights are usually standard but variations can impart certain qualities--and will affect cost) F. Aesthetic value	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: FINISH MATERIALS

TASK: (No. 21) LIST TYPES OF TRIM NEEDED AROUND HOUSE, DETERMINING AMOUNT AND COST

COMPETENCY: AWARENESS OF AREAS NEEDING FINISHING WORK

CRITERION MEASURE:
RECOGNIZES NEED FOR TRIM MATERIALS (AESTHETIC PURPOSES, SEALING HOUSE FROM ENVIRONMENT)
ABLE TO MEASURE FOR TRIM
ESTIMATES KINDS OF FINISHING MATERIALS AND THEIR COST

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. List areas needing finishing	I. Areas under consideration A. Interior 1. Doors a) Knobs b) Sills c) Cove molding 2. Windows a) Sills b) Cove molding 3. Cabinet knobs or pulls B. Exterior 1. Rakes 2. Cornices 3. Gutter	I. Awareness of finish materials necessary and costs involved
II. List amount of materials needed for each item	II. Materials usually measured square feet or linear feet	
III. Get estimates for costs	III. Cost considerations A. Materials B. Labor C. Finishing D. Skill involved	

REFERENCES (see Bibliography for complete information)

Other Homes and Garbage
See previous descriptions.

From the Ground Up
See previous descriptions.

So You Want to Build a House?
See previous descriptions.

ENVIRONMENTAL CONTROL SYSTEMS

ENVIRONMENTAL CONTROL SYSTEMS

The section on planning included discussion of basic approaches to heating. This class should focus on strengths and limitations of various systems and their adaptability to specific houses. Basic to any consideration of a heating source is a calculation of theoretical heat loss from the house. A form for this calculation is included. Heat loss calculations may be done on many levels of sophistication. The one included will be adequate for most owner/builder situations. With this information the student can verify the theoretical cost of heating his/her house.

Checklist Review of Planning/Design of Basics for Heating System.

Forced Air Systems

1. Do not oversize furnace as it will cycle. When matching capacity of furnace to design load, selecting a slightly smaller capacity means furnace will run longer and more efficiently.

2. For oil or bottled gas consider installing oversized tank to allow yearly fill in the summer when prices are low and supplies plentiful.

3. Advise subcontractor designing system that duct work design should be done with a maximum static pressure of 1/10" per 100 feet. This will control noise in system.

4. Return air grille should be near ceiling to return rising warm air back to the system.

5. Duct work in uninsulated space should be insulated with minimum 2" fiberglass wrap.

6. Vary clearance for duct work, particularly for vertical chases in two-story construction.

7. Consider adding humidifier to system which will lower the house temperature required for comfort and apparently reduce the number of family colds through the winter.

8. Verify location of filter. If furnace is in crawl space or attic consider using a filter grille inside the house at the return air grille.

9. Verify size and weight of equipment to be used and check for clearances.

10. Verify requirements of utility for location and requirements for access to equipment and requirements for flues.

Radiant

1. Verify that your equipment has individual thermostats if required.

2. Consider placement of baseboard units relative to furniture, drapes, etc.

3. If you intend to use solar or woodfired boiler to assist in heating water for heat verify that sizing has taken into consideration lower temperature supply (i.e., solar water at ±140°).

Wood Heat

1. Size capacity of stove to match or exceed design loss of house.

2. Calculate wood requirement for winter and provide space for wood storage outside and inside.

3. Consider path from outside storage to stove for clearing, and walking with heavy load problem.

4. Consider need for providing air circulation systems to move heat around the house.

5. Commitment to fill and clean stove regularly through winter.

6. Properly insulated chimney, sized for the selected stove.

7. Back up system.

Theoretical calculations for wood stove output is available from Popular Science, February 1976, "Wood as Fuel."

Passive Systems

1. Proper orientation of glass and consideration of summer sun control by overhangs, awnings, deciduous tree cover, etc.

2. Maximization of thermal mass within volume of the house.

3. Design of movable insulation (insulating shutters) to restrict heat flow out of south glass at night.

4. Need for air circulation systems to spread heat from collectors through house.

5. Commitment to operate manual controls which make the system work.

6. Back up system.

Calculating output for passive systems is extremely difficult beyond the level of rule of thumb judgments. Guidelines for calculations are available in The Solar Home Book. Check for availability of a new passive design manual being prepared by Los Alamos Scientific Laboratory, and Total Environmental Action, which should be available in the Spring of 1979.

Natural Cooling

Consider ways to lower interior temperatures by ventilation in the summer without employing mechanical cooling.

Shading

Consider ways to site houses which provide tree cover, particularly on the south and west to minimize heat gain through glass and walls. Overhangs should be designed for the south side, which restrict most summer sun while admitting winter sun.

Ventilation (house)

Consider ways for warm rising air to leave the house, admitting cooler air. High venting, opening windows, turbine ventilators, and "attic" (house) ventilation fans are some methods. Students should be advised that house ventilation systems should have a capacity of ±1/2 to 1 air charge per minute (example: a 1200 square foot house with eight foot ceiling heights has 9600 cubic feet, a ventilation system should be capable of 4500 to 9600 C.F.M. to be most effective).

Ventilation (attic)

Improperly vented attic/roof spaces add heat to the house, reduce life expectancy for roofing materials, and can cause moisture problems within the space. Consider methods for venting. Soffit vents, ridge vents (far more effective than gable vents), gable vents, attic fans, turbine vents should be discussed.

Plumbing System

Building Your Own Home offers basic information in plumbing and wiring for the owner-builder. It is important to verify all designs for both plumbing and heating with code authorities before beginning.

Electrical System

The National Electrical Code sets minimum requirements for wiring. Among these are a requirement for one duplex every 12' of wall and one switched outlet or light fixture per room. In designing an electrical plan, placement of lights, switches and outlets should be governed by room use. It is wise to do furniture layouts to locate places outlets will be needed.

Light fixtures come in two varieties: fluorescent and incandescent. Fluorescent lighting is about three times more efficient to use than incandescent and should be considered when it can be adapted to the design.

Branch wire should be copper. Aluminum is allowed for larger circuits such as hot water heaters, electric ranges, and furnaces. However, copper is much safer and should always be used if it is available in the required wire size.

An electrical permit can be obtained by the owner-builder from the city or county planning department provided he/she demonstrates sufficient knowledge and/or experience in wiring to be expected to successfully complete the wiring to meet the National Electric Code and pass the required electrical inspections. Obtaining an electrical permit may require a plan showing outlets, lights and switches.

Review Handout #19, which is an electrical plan for the case house.

Plumbing Design and Materials

In designing the plumbing system, care should be taken to concentrate plumbing in a central area if at all possible. The concept of backing up plumbing will indeed save money. Selection of fixtures can make quite a difference in cost. For example, the basic stainless steel kitchen sink, because of the tremendous manufacturing volume costs less than $20.00, the next larger size costs over $75.00. Students should be encouraged to discuss availability and cost of fixtures with a supplier.

Water lines are generally of copper although some codes now allow plastic. Sewer lines and vents can be either plastic, which is extremely easy to put together, or cast iron which is quieter but also more expensive and more difficult to install for the owner-builder.

Another major choice in plumbing fixture selection is between cast iron tubs and fiberglass. Influencing factors include cost, size of tub or shower, ease of installation, safety, and overall quality.

Production of domestic hot water is one of the major energy demands for the house. The student should consider several options for lowering the cost of domestic hot water. Solar hot water systems generally cost from $1000 to $1500 (part of which is deductible on North Carolina tax returns) and can provide up to 100 percent of the hot water needs for a family of four. Payback period is generally set at ± eight years. Discussion of physical requirements of the system should include collector location, preheat tank location, type of freeze protector, and controls. Students should also be made aware of the availability of "demand" hot water heaters. Powered by electricity or gas, these heaters come on only when the system requires hot water, eliminating the cost of keeping a stored volume of water up to domestic hot water temperature. The cost of these units is roughly equivalent to installation of a standard unit. Electric timers are also available which cut off water heating elements for certain periods of the day when hot water is not required. Emphasis should also be placed on controlling heat loss in this system.

Renovation of Plumbing, Electrical and Mechanical Systems

Existing plumbing systems have potential problems that may require replacing galvanized water piping, old valves or fixtures for which repair parts are no longer available.

Older electrical systems can be of several varieties. Knob and tube wiring is the oldest type but generally is considered reliable by most

inspectors. New circuits should be added rather than adding on to old circuits. Bx (shielded) cable is particularly difficult to work with in renovation and is considered dangerous because of problems with the metal shielding coming in contact with a live wire. The size of an older electrical service should be checked, as it will probably be too small for current electrical needs and enlarging the service can be a relatively expensive project.

Existing mechanical systems should be carefully inspected and, if possible, discussed with a company that has maintained that system or one like it. Oil, gas and electric heat sources should be inspected and given a careful tune-up to improve efficiency. Ask around for a reputable company in your area. Insulating ducts and pipes can greatly improve the efficiency of a mechanical system. It is generally concluded that the payback period for retrofitting duct insulation is three years. If there is an existing forced air heating system, consider moving the return air duct up to the ceiling area. Also, consider adding a humidifier. Drum type is less maintenance prone, especially on well or spring water.

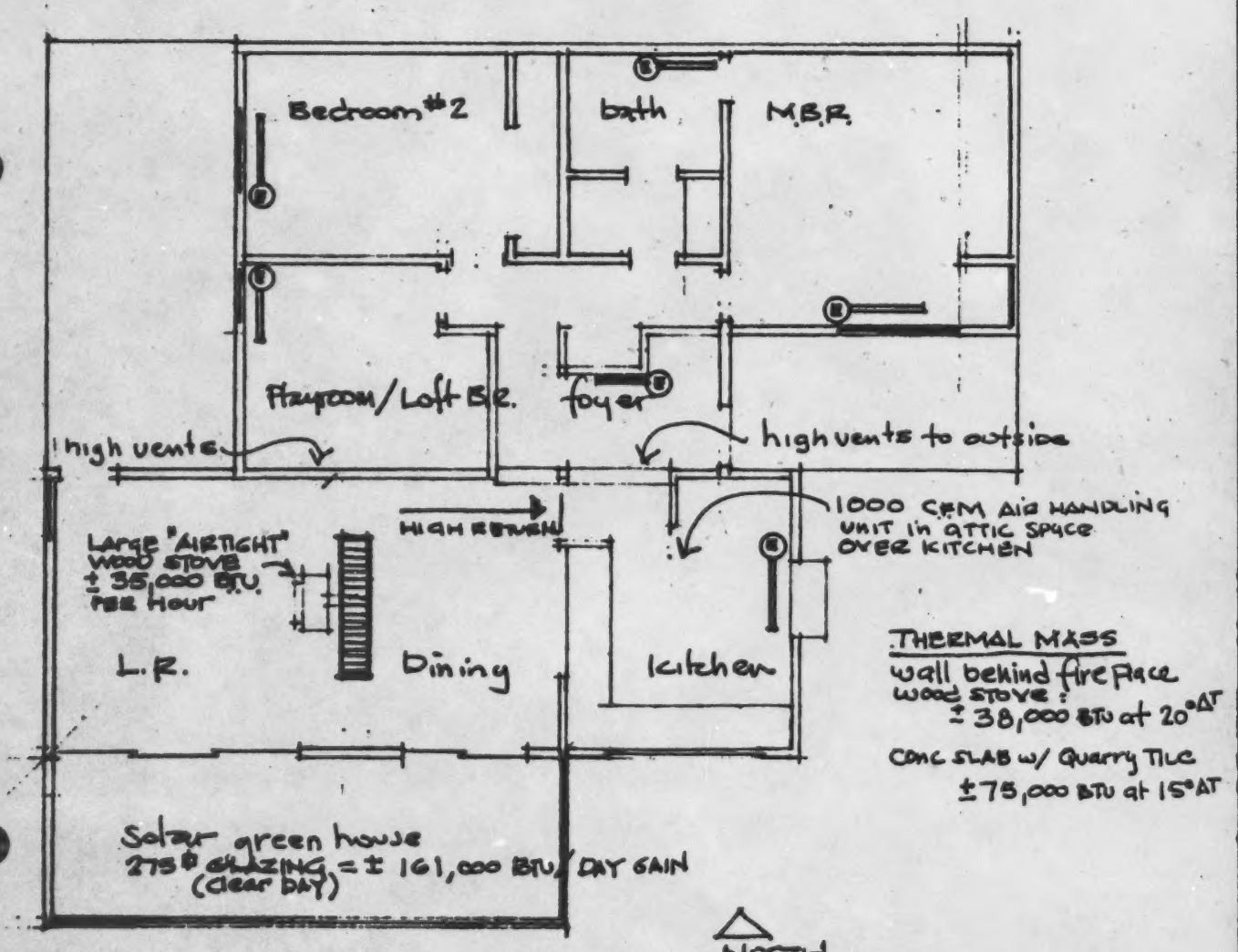
In most all cases involving renovation work, it would be wise to contact the various inspectors before beginning. They will probably have ideas which may be helpful, and their interpretation of the codes can be valuable information.

HANDOUT #18
HEATING AND VENTILATION - Case House

Approach.

- primary heating source. large wood stove in public space. bedroom area will have baseboard electric as back up. Solar greenhouse will also act as back up.
- Duct system will be used to circulate warm air throughout the house. System will be zoned so owner can make choice when wood stove/greenhouse are not able to supply enough heat for entire house.

There is no mechanical cooling. Ventilation is optimized by high windows over foyer and 3rd bedroom which will allow hot air to leave the house and be replaced by cooler.


Bedroom #2
bath
M.B.R.
Playroom/Loft B.R.
foyer
high vents
high vents to outside
HIGH RETURN
1000 CFM AIR HANDLING UNIT in ATTIC SPACE OVER KITCHEN
LARGE "AIRTIGHT" WOOD STOVE ± 35,000 BTU PER HOUR
L.R.
Dining
Kitchen
THERMAL MASS
wall behind fire place wood stove: ± 38,000 BTU at 20°ΔT
CONC SLAB w/ Quarry TILE ±75,000 BTU at 15°ΔT
Solar green house 275# GLAZING = ± 161,000 BTU/DAY GAIN (clear day)
NORTH

156

HANDOUT #19

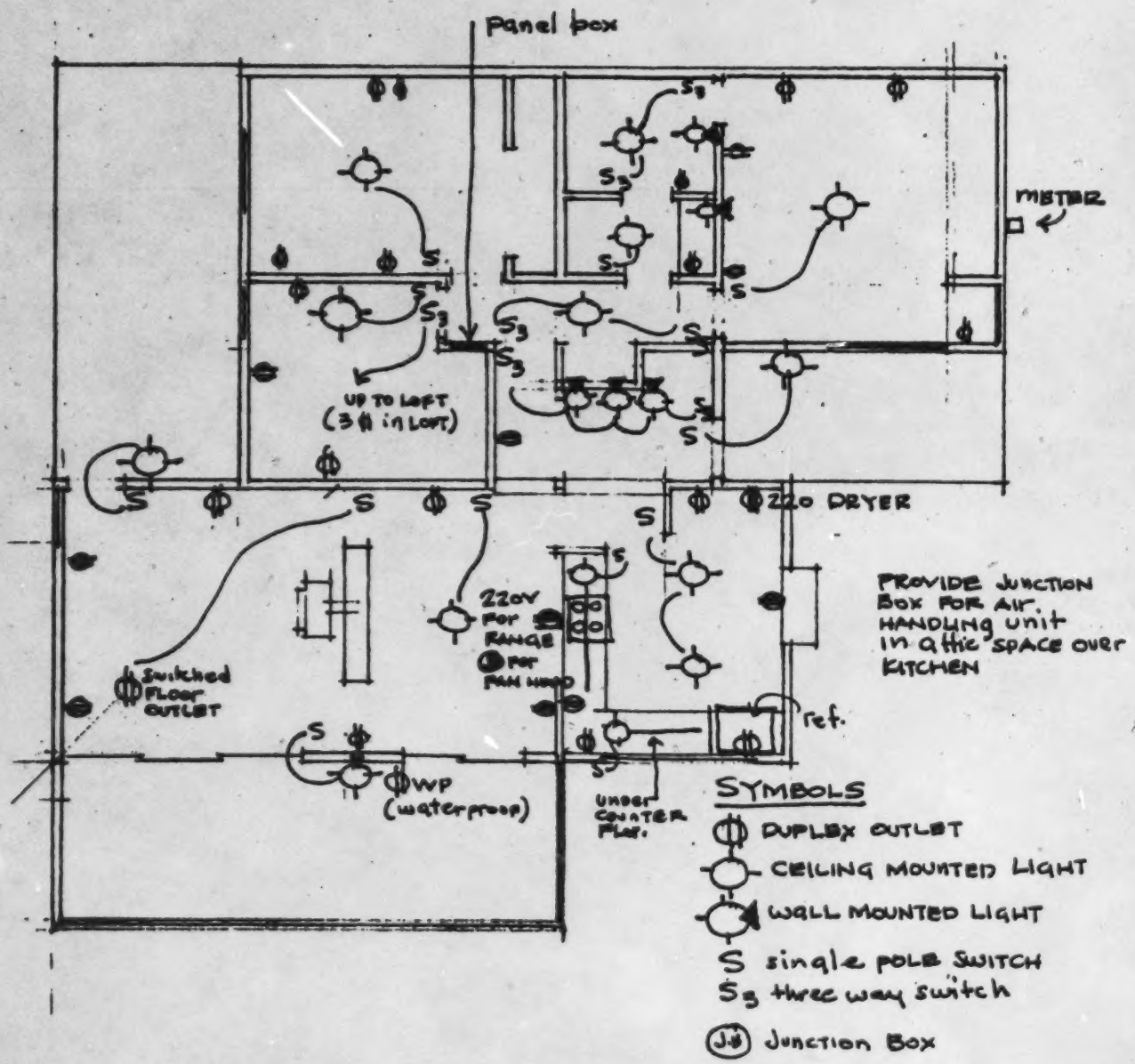
ELECTRICAL PLAN

CASE HOUSE

Piedmont, N.C.

ELECTRICAL FIXTURES

BECAUSE OF ECONOMY ALL LIGHT FIXTURES ARE PORCELAIN SOCKETS WITH 5" GLOBE LIGHTS OR SIMPLE FLUORESCENT



HEAT LOSS CALCULATION FORMS A & B

Form A is a fairly elaborate section-by-section analysis of construction systems and losses in the house and is recommended for all but the simplest house and heating system. Form B is a very basic calculation form which can be successfully used for schematic design and simpler houses.

The following glossary and table of R-values will prove helpful in making heat loss calculations.

GLOSSARY

Calculating Heat Loss and Solar Gain

B.T.U. - British Thermal Unit. Quantity of heat required to increase the temperature of 1 lb. of water 1 degree F.

Heat Loss - Amount of heat that passes through the exposed surfaces of the house for average temperatures.

Solar Gain - Heat gained from the sun. With the insulating glass the solar gain on a January day in the Raleigh-Durham-Chapel Hill area will be 560 B.T.U.s per square foot.

Inside Design Temperature - The desired room temperature level. This is usually 65^{0}-70^{0}.

Outside Design Temperature - Outside Design Temperature is the average outdoor temperature for the winter months. An average of the coldest temperatures for the months of October to March is used to determine Outside Design Temperature. You can find Outside Design Temperature for your area.

Design Temperature Difference - Difference between IDT and ODT.

Infiltration - Heat loss through spaces around sills, windows and doors. For calculating purposes it has been established that infiltration is equal to one air exchange per hour. This is equal to the volume of space in a house.

R-Factor - Resistivity or the ability to resist transfer of heat or cold.

HEAT LOSS FORM/TABLE OF R-VALUES

Table of R-Values for Common Materials

Concrete or Stone (4")	.32	Asphalt Shingles	.16
Concrete or Stone (6")	.48	Wood Shingles	.86
Concrete or Stone (8")	.64	Tile or Slate	.08
Concrete or Stone (12")	.96	Plywood (1/2")	.65
Concrete Block (4")	.70	Plywood (5/8")	.80
Concrete Block (8")	1.10	Plywood (3/4")	.95
Concrete Block (12")	1.25	Softwood Siding (3/4")	.85
Brick (Common)	.82	Composition Floor (3/4" Covering)	.08
Brick (Face)	.45	Single Thickness Glass	.88
Clay Tile (Structural 4")	1.10	Double Paned Insulating Glass	1.88
Clay Tile (Structural 8")	1.90	Single Glass w/Storm Window	1.66
Clay Tile (Structural 12")	3.00	Metal Edge Insulating Glass	1.85
Stucco (1")	.20	Glass Block (4")	2.13
Building Paper (15 lb.)	.06	Wood Door (1-3/8")	1.92
Sheetrock (3/8")	.33	w/Storm Door	3.12
Fiberboard Sheathing (1/2")	1.45	Wood Door (1-3/4")	1.82
Fiberboard ceiling Tile (1/2")	1.20	w/Storm Door	2.94
Fiberboard Sheathing (3/4")	2.18		
Roll Roofing	.15		

More complete R-tables, degree day information, solar, insulation tables, etc. can be found in The Solar Home Book.

HANDOUT #20

HEAT LOSS CALCULATION FORM A

Conduction Heat Loss--Walls, Roof, Floor, Windows

1. For each type of construction draw section of system and add "R" values for that system.

2. Determine the number of square feet of each type of construction.

3. Determine the design temperature difference by establishing minimum comfort level inside house ($\pm 65^{o}$) and minimum expected outside temperature ($\pm 5^{o}$). Subtract outside temperature from inside temperature to determine design temperature difference ($\pm 60^{o}$).

   To determine the heat loss through a system multiply:

   $$\text{Area of system (sq. ft.)} \times \text{temp. difference (in degrees)} \times \frac{1}{\text{"R" factor}} = \_\_\_\_\_ \text{BTU/hour loss}$$

Infiltration Heat Loss

Generally, the infiltration into a house is considered to be 1/2 to 1-1/2 air charges per hour for a well insulated, weather stripped house. The 1/2 air charge per hour rate would be achieved only with the best construction and with "air lock" entrances.

1. Determine rule of thumb air charge rate.

2. Multiply that number times the number of cubic feet in the house times .018, which is the specific heat of air, and by the temperature difference between outside design temperature and inside design temperature. The sum of all BTU/hour loss figures equal the design loss of the house (room). This figure should be used to size solar gain and furnace requirements.

Calculation of Seasonal Heating Cost

Multiply degree days for local x 24 hours x design loss of house and divide by temperature difference used in calculations. The result will be the number of BTUs required for the heating season.

The value of solar heating systems should be taken into account here. Reference The Solar Home Book for methods of calculation.

HANDOUT #21

HEAT LOSS CALCULATION FORM B

JOB NAME DATE:

		Heat Gain			Heat Loss		
		Factor	Area	BTU/hr	Factor	Area	BTU/hr
WINDOWS (Use all window area)							
Single pane glass		17X		=	69X		=
Double pane or glass block		9X		=	36X		=
WALLS & PARTITIONS (Use net wall area)							
No insulation		5X		=	18X		=
1 - inch insulation		4X		=	15X		=
2 - inch insulation		2X		=	9X		=
3 - inch insulation		2X		=	6X		=
4 - inch insulation		1X		=	5X		=
6 - inch insulation		.51X		=	2.6X		=
Partitions between conditioned and unconditioned spaces		3X		=	12X		=
ROOFS & CEILINGS (Use ceiling area)							
Pitched Roof	No insulation	19X		=	19X		=
	No insulation - attic fan	12X		=			=
	2 - inches insulation	5X		=	6X		=
	4 - inches insulation	4X		=	5X		=
	6 - inches insulation	3X		=	4X		=
	8 - inches insulation	1.5X		=	1.8X		=
Flat Roof	No insulation	30X		=	30X		=
	1 - inch insulation	15X		=	13X		=
	1½ - 2 inches insulation	9X		=	11X		=
	3 - 4 inches insulation	6X		=	6X		=
	6 - inches insulation	5X		=	5X		=
Ceilings under unconditioned spaces		4X		=	15X		=
FLOORS							
	Over unconditioned room	3X		=	12X		=
	Over open crawl space	4X		=	18X		=
	Over slab or closed space	0		=	9X		=
	With 2" insulation	0		=	6X		=
	With 6" insulation	0		=	2.6X		=
OUTSIDE AIR (Use total floor area)							
One A/C per hour		2X		=	9X		=
PEOPLE LOAD (Use minimum of 5 people)							
Use number of people x 200		200X		=			
WINDOW - SOLAR (Use greatest load only)							

Overhang 0	1'	2'	3'	4'		Factor	
35	35	35	35	35	NE	X	=
40	36	32	28	24	E	X	=
40	30	21	11	2	SE	X	=
35	22	9	0	0	S	X	=
51	39	27	15	3	SW	X	=
65	58	52	45	39	W	X	=
55	55	55	55	55	NW	X	=

TOTAL SENSIBLE LOAD

30% LATENT HEAT ALLOWANCE

GRAND TOTAL LOAD*

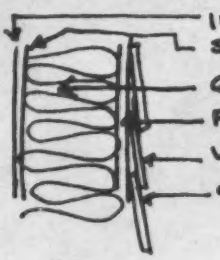
*BASED ON DESIGN TD OF 15° IN SUMMER AND 60° IN WINTER

HANDOUT # 22

CASE HOUSE

Heat Loss Calculation

walls

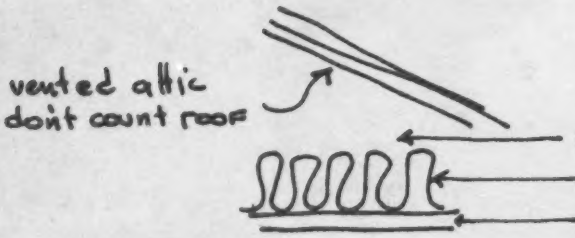


INSIDE AIR FILM	.68
SHEETROCK	.45
6" FIBERGLASS	19.00
FIBER SHEATHING	2.06
WOOD SIDING	.81
OUTSIDE AIR FILM	.17
R =	23.17

net wall area 1638 ☐

loss = $1638 \times 60° \times \frac{1}{23.17}$ = 4242 Btu/hr @ 60°

ROOF (attic space)

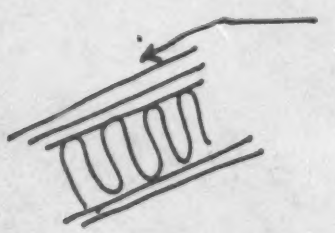


still air film	.62
R-30 ins	30.00
sheetrock	.45
still air film	.62
R =	31.69

net attic space roof 835 ☐

loss $835 \times 60° \times \frac{1}{31.69}$ = 1581

ROOF (RAFTER SPACE)

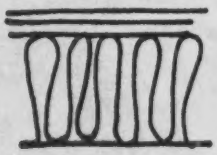


outside air film	.17
ASPHALT SHINGLES	.15
1/2" plywood	.62
3/4 Airspace	.81
R 30 BATT	30.00
sheetrock	.45
inside air film	.62
R =	32.82

net (rafter space) Roof 584 ☐

loss $584 \times 60° \times \frac{1}{32.82}$ = 1068

FLOOR AREA (crawl space)

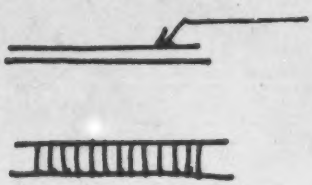


still air film	.62
OAK FLOOR	.68
SUB FLOOR	.94
BIG BATT	19.00
still air	.62
	R = 21.86

net crawl space FLOOR 740#

loss $740 \times 60° \times \frac{1}{21.86} =$ 2031

FLOOR AREA (SLAB)



still Air film	.62
QUARRY TILE	.05
4" concrete	.8
¾" styrofoam	3.00
	R = 4.47

net floor area 550#

loss $550 \times 10°* \times \frac{1}{4.47} =$ 1230

* assume slab temperature difference is 10° (against ± 55° EARTH)

WINDOWS (double glazed)

R = 1.34

net window area 341#

$341 \times 60° \times \frac{1}{1.34} =$ 15,268

INFILTRATION

Figure ¾ air changes per hour

11,700 cubic ft. × .75 × 60° × .018 = 9477

total design loss at 60° = 34,897 BTU/Hour
at 60° temp. diff.

this is = 27 BTU/sq. ft which is high for an energy efficient house. Heat Loss calculation does not recognize heat gain on south side through glass. A more sophisticated analysis would analyze and include this gain. (see the Solar Home Book)

Seasonal Heating Cost.

factors 3400 Degree Day climate
34,897 BTU/Hour design loss
60° temp. difference.

$$\frac{3400 \times 24\text{hr.} \times 34{,}897}{60^\circ} = 47{,}459{,}916 \text{ BTU/year}$$

discounting solar gain the cost of electric heat would be

47,459,916 × .000293 = 13,905 kilowatts
(Btu to kilowatts)

13,905 × .04 (local electrical rate) = $556.00
to heat with wood at $60 (per cord)

$$\frac{47{,}459{,}916}{13{,}800{,}000 \text{ (Btu/cord in "airtight stove")}} = 3.44 \text{ cord} \times \$60 = \$206.00$$

Rule of Thumb for solar greenhouse heat contribution expects 1-4 square feet of house floor space will be heated for each square foot of greenhouse glazing.

Case house has 300# of glazing in greenhouse. Using 2#/foot of glazing, greenhouse will heat 600# of house reducing seasonal cost to 64%. or 30,374,346 Btu

Case family will burn 2 cords of wood per season at $60/cord = $120.00

2 cords at 13,800,000 = 27,600,000 Btu w/wood
remainder w/resistance heat 2,774,346 Btu

2,774,346 Btu x .000293 = 812 kilowatts
(Btu to kilowatt)

812 kilowatts x .04 $32.50

total winter heating cost = $152.50

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: ENVIRONMENTAL SYSTEMS

TASK: (No. 22) DRAW SCHEMATIC FOR ELECTRICAL SYSTEM

COMPETENCY: UNDERSTAND AMOUNTS OF MATERIALS NEEDED FOR ELECTRICAL SYSTEM, CONSIDERATIONS FOR LEGAL AND SAFETY REQUIREMENTS

CRITERION MEASURE:
LISTS MATERIALS FOR ELECTRICAL POWER--TEMPORARY AND PERMANENT
DRAWS SCHEMATIC FOR ELECTRICAL SYSTEM IN HOUSE
KNOWS BASIC REQUIREMENTS FOR TEMPORARY ELECTRICAL POWER (TO BE USED DURING CONSTRUCTION)

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Basic requirements for electrical system	I. Basic materials A. Service entrance (panel box) B. Convenience outlets C. Switches D. Meter (unless you generate your own power) E. Lighting (built-in) 1. Fluorescent 2. Incandescent F. Wiring--Conduit	I. Awareness of all the parts necessary to make the electrical system work
II. Safety and legal requirements	II. Safety and legal requirements A. Legal 1. Service electrical power inspections 2. Rough electrical inspection 3. Finished electrical B. Safety 1. Ground for outlets 2. Ground for service conductors	II. Understanding of requirements to insure the safety of the system

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: ENVIRONMENTAL SYSTEMS

TASK: (No. 23) DRAW PLANS FOR ROUGH PLUMBING

COMPETENCY: KNOWLEDGE OF MATERIALS AND SKILLS NEEDED TO INSTALL A PLUMBING SYSTEM (GETTING WATER TO HOUSE AND WASTE DISPOSAL SYSTEM)

CRITERION MEASURE:
RECOGNIZES COMPONENTS OF PLUMBING SYSTEM
PLANS HOUSE FOR OPTIMUM EFFICIENCY OF SYSTEM
KNOWS REGULATIONS FOR INSTALLING A PROPER PLUMBING SYSTEM

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Parts needed for conventional system	I. Components of system A. Pipe 1. Galvanized steel 2. Plastic 3. Copper B. Building main C. Hot water heater 1. Solar 2. Gas 3. Electric D. Fixtures 1. Bathtub 2. Sinks 3. Toilet 4. Other F. Sewage disposal 1. Main stacks 2. Secondary stacks 3. Vent stacks 4. House stacks G. Sewage treatment 1. Septic tank 2. Disposal field	I. Understand reasons for all components of plumbing system

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
II. Legal and safety requirements	II. Legal and safety considerations A. Inspections B. Septic tank size C. Disposal field size	II. Know requirements or restrictions on locations
III. Alternative sewage systems	III. Alternative systems A. Clivus multrum B. Outhouse	III. Be aware of all possible sewage disposal systems

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: ENVIRONMENTAL SYSTEMS

TASK: (No. 24) FIGURE HEATING REQUIREMENTS FOR DWELLING

COMPETENCY: TO BECOME FAMILIAR WITH CALCULATIONS FOR HOME HEATING REQUIREMENTS

CRITERION MEASURE:
FINDS R-FACTOR FOR ALL AREAS OF HOUSE
FINDS WINTER DESIGN TEMPERATURE OF HOUSE
DETERMINES BTU LOSS/HR FOR HOUSE
DETERMINES SIZE OF HEATING OR COOLING SYSTEM FOR DWELLING

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Calculate heat losses for winter	I. Follow through calculations A. Get outside design temperature for location from local weather station B. Find R-values for all materials used C. Calculate BTU's lost from dwelling	I. Selection of best, most effective, energy conserving system for house
II. Calculate possible solar gain from southern orientation	II. Figure solar gain A. Find window areas B. Determine total solar gain	
III. Consider solar house heating with backup	III. Alternate heat sources A. Passive solar construction 1. Windows 2. Trombe wall 3. Large thermal mass 4. Attached greenhouse B. Active solar 1. Water system 2. Air system C. Back-up systems 1. Conventional--Gas, oil, electric 2. Alternative Wood Wind	

REFERENCES (see Bibliography for complete information)

The Solar Home Book

The Wood Burners Encyclopedia

The Homeowners Energy Guide is a discussion of basics of heat loss and gain and ways to deal with energy savings.

GETTING READY TO BUILD

GETTING READY TO BUILD

The individual getting ready to build will need access to a number of sources of information to develop actual costs for the house planned.

Materials List

Students should be encouraged to make a very thorough materials list to enable them to gather prices from materials suppliers. The instructor should help formulate these lists and review them for completeness. Students may be likely to underfigure or forget waste, portions of board siding covered in lapping, expendable materials such as plastic for keeping materials dry, batter boards, etc.

The enclosed materials list is used by Carolina Builders Corporation of Raleigh to develop job costs for the materials they supply for housing projects. It is not a complete list, as they do not carry all items required for construction of a house. It should serve as a useful guide for the students as to form and degree of detail their materials list should take. After completing the list several suppliers should be asked to bid on it. Materials prices are unstable and bids should be partially evaluated based on the supplier's commitment to hold prices. Sometimes it makes sense to get materials from different dealers. For example, a large lumber dealer may be retailing pressure treated lumber from a local plant where you can obtain cheaper prices.

Financing

Local banks should have already been contacted to determine their specific requirements for the financing application package. Generally they will require:

- Floor plans, elevations, and wall section of your house
- Copy of deed for land which will be the house site
- Material specifications (sample enclosed)
- Cost estimates
- Credit information application (sample enclosed)

Bank financing may be difficult for the owner-builder. Time should be spent putting this information in a very orderly, neat, properly typed format. Provide a breakdown of costs and copies of suppliers and subcontractors contracts as documentation. Every effort should be made to prove to the banker (loan committee) that the project has been well considered and that every conceivable effort has been made to determine what is required to complete the house. The owner-builder may benefit from talking to numerous lending agencies and if necessary returning for clarification of requirements prior to a final application for a loan.

Subcontractor Contracts

Obtain contract prices for work that is to be subcontracted. If possible, get at least three bids on subcontracted work before deciding who to

have do the job. There is always the option of negotiating price with one subcontractor (preferably whose work and reputation for fair pricing are known). The negotiation approach will require less documentation.

In either case it should be emphasized that every attempt should be made to determine what exactly is a part of the contract and what is not. Specific areas which need to be considered include:

- Who buys materials
- Who cleans up
- What is the procedure for change orders
- What will be the qualities of various materials
- Who covers the cost of escalation of materials, should that occur
- What will be the schedule for payment (which should leave the owner at all times with enough cash in the contract to complete the work should the subcontractor fail for any reason to complete the job)
- What is the estimate or promise of a time schedule.

Siting

Generally siting choices should have already been made. However, at the point of beginning it is important to verify that the house is on the site and within the setback lines. On small sites a surveyor should be employed for that purpose. Stake the corners and locate windows to check views.

Insurance

Prior to beginning construction or authorizing anyone to begin, the student should check with an insurance agent to secure necessary insurance to cover the liabilities incurred in the work. Normally "building risk" and "homeowners" policies will cover what is needed. The lending agency will often have specific requirements.

Motivation

The process of construction can be a strain on all life systems. The individual should be encouraged to acknowledge this potential and as much as possible be prepared. The building process can be a rewarding one if the owner (builder) is prepared to accept the fact that drawing the plan does not build a house. The construction process is full of changes, compromises, disappointments, setbacks and successes. All members of the family unit should be involved and committed to the building and decision-making process. A construction project of this size will take a minimum of several months and possibly stretch into several years. For individuals not accustomed or experienced in this type activity there is potential for physical (and mental) health problems if there are too many personal or family demands that result from the project. It is helpful to have friends who can, if nothing else, provide encouragement along the way. There will be times that individuals will need reminding to laugh at their mistakes. It is important that individuals be oriented to taking care of themselves first.

Tools

For a discussion of the positive relationship that can develop between builder and well-made tools, and a basic tool list, see Chapter 2, "Tools" in Building for Self-Sufficiency. The instructor should emphasize that cheap tools are just that and will in the end probably have to be replaced with good quality tools to complete the job. Also important to discuss is the detrimental effect on power tools of using undersized power wire for extension cords. Rental of expensive tools is an excellent option for saving money.

Permits

Don't start construction until permits have been obtained. Refer to the planning guide developed earlier in the course and take copies of the plans for permits. The chance of getting caught starting early and compromising your credibility with the inspector is not worth it. Remember that many building inspectors, given the slightest chance, can become a valuable advisor for your project.

Job Record Keeping

Enclosed forms should be used as a cumulative total of job costs. In addition, keeping careful records of conversations, regarding recommendation changes, costs from inspectors or contractors should be dated and kept. A job logbook can be a fascinating record of the history of the job, recording people who helped, how the individual felt at particular stages of the work, etc., and should be recommended just for fun.

HANDOUT #23

U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION

FHA Form 2005
VA Form 26-1852
Rev. 2/75

For accurate register of carbon copies, form may be separated along above fold. Staple completed sheets together in original order.

Form Approved
OMB No. 63-R0055

☐ Proposed Construction

☐ Under Construction

DESCRIPTION OF MATERIALS

No. _____ (To be assigned by FHA or VA)

Property address _____ City _____ State _____

Mortgagor or Sponsor _____ (Name) _____ (Address)

Contractor or Builder _____ (Name) _____ (Address)

INSTRUCTIONS

1. For additional information on how this form is to be submitted, number of copies, etc., see the instructions applicable to the FHA Application for Mortgage Insurance or VA Request for Determination of Reasonable Value, as the case may be.
2. Describe all materials and equipment to be used, whether or not shown on the drawings, by marking an X in each appropriate check-box and entering the information called for in each space. If space is inadequate, enter "See misc." and describe under item 27 or on an attached sheet. THE USE OF PAINT CONTAINING MORE THAN ONE HALF OF ONE PERCENT LEAD BY WEIGHT IS PROHIBITED.
3. Work not specifically described or shown will not be considered unless required, then the minimum acceptable will be assumed. Work exceeding minimum requirements cannot be considered unless specifically described.
4. Include no alternates, "or equal" phrases, or contradictory items. (Consideration of a request for acceptance of substitute materials or equipment is not thereby precluded.)
5. Include signatures required at the end of this form.
6. The construction shall be completed in compliance with the related drawings and specifications, as amended during processing. The specifications include this Description of Materials and the applicable Minimum Property Standards.

1. EXCAVATION:

Bearing soil, type _____

2. FOUNDATIONS:

Footings: concrete mix _____; strength psi _____ Reinforcing _____

Foundation wall: material _____ Reinforcing _____

Interior foundation wall: material _____ Party foundation wall _____

Columns: material and sizes _____ Piers: material and reinforcing _____

Girders: material and sizes _____ Sills: material _____

Basement entrance areaway _____ Window areaways _____

Waterproofing _____ Footing drains _____

Termite protection _____

Basementless space: ground cover _____; insulation _____; foundation vents _____

Special foundations _____

Additional information: _____

3. CHIMNEYS:

Material _____ Prefabricated (make and size) _____

Flue lining: material _____ Heater flue size _____ Fireplace flue size _____

Vents (material and size): gas or oil heater _____; water heater _____

Additional information: _____

4. FIREPLACES:

Type: ☐ solid fuel; ☐ gas-burning; ☐ circulator (make and size) _____ Ash dump and clean-out _____

Fireplace: facing _____; lining _____; hearth _____; mantel _____

Additional information: _____

5. EXTERIOR WALLS:

Wood frame: wood grade, and species _____ ☐ Corner bracing. Building paper or felt _____

Sheathing _____; thickness _____; width _____; ☐ solid; ☐ spaced _____" o. c.; ☐ diagonal: _____

Siding _____; grade _____; type _____; size _____; exposure _____"; fastening _____

Shingles _____; grade _____; type _____; size _____; exposure _____"; fastening _____

Stucco _____; thickness _____"; Lath _____; weight _____ lb.

Masonry veneer _____ Sills _____ Lintels _____ Base flashing _____

Masonry: ☐ solid ☐ faced ☐ stuccoed; total wall thickness _____"; facing thickness _____"; facing material _____

Backup material _____; thickness _____", bonding _____

Door sills _____ Window sills _____ Lintels _____ Base flashing _____

Interior surfaces: dampproofing, _____ coats of _____; furring _____

Additional information: _____

Exterior painting: material _____; number of coats _____

Gable wall construction: ☐ same as main walls; ☐ other construction _____

6. FLOOR FRAMING:

Joists: wood, grade, and species _____; other _____; bridging _____; anchors _____

Concrete slab: ☐ basement floor; ☐ first floor; ☐ ground supported; ☐ self-supporting; mix _____; thickness _____"; reinforcing _____; insulation _____; membrane _____

Fill under slab: material _____; thickness _____". Additional information: _____

7. SUBFLOORING: *(Describe underflooring for special floors under item 21.)*

Material: grade and species _____; size _____; type _____

Laid: ☐ first floor; ☐ second floor; ☐ attic _____ sq. ft.; ☐ diagonal; ☐ right angles. Additional information: _____

8. FINISH FLOORING: *(Wood only. Describe other finish flooring under item 21.)*

Location	Rooms	Grade	Species	Thickness	Width	Bldg. Paper	Finish
First floor							
Second floor							
Attic floor	_____ sq. ft.						

Additional information: _____

DESCRIPTION OF MATERIALS

9. PARTITION FRAMING:
Studs: wood, grade, and species _____ size and spacing _____ Other _____
Additional information: _____

10. CEILING FRAMING:
Joists: wood, grade, and species _____ Other _____ Bridging _____
Additional information: _____

11. ROOF FRAMING:
Rafters: wood, grade, and species _____ Roof trusses (see detail): grade and species _____
Additional information: _____

12. ROOFING:
Sheathing: wood, grade, and species _____; ☐ solid; ☐ spaced ____" o.c.
Roofing _____; grade _____; size _____; type _____
Underlay _____; weight or thickness _____; size _____; fastening _____
Built-up roofing _____; number of plies _____; surfacing material _____
Flashing: material _____; gage or weight _____; ☐ gravel stops; ☐ snow guards
Additional information: _____

13. GUTTERS AND DOWNSPOUTS:
Gutters: material _____; gage or weight _____; size _____; shape _____
Downspouts: material _____; gage or weight _____; size _____; shape _____; number _____
Downspouts connected to: ☐ Storm sewer; ☐ sanitary sewer; ☐ dry-well ☐ Splash blocks: material and size _____
Additional information: _____

14. LATH AND PLASTER
Lath ☐ walls, ☐ ceilings: material _____, weight or thickness _____ Plaster: coats ____; finish _____
Dry-wall ☐ walls, ☐ ceilings: material _____; thickness _____; finish _____;
Joint treatment _____

15. DECORATING: *(Paint, wallpaper, etc.)*

Room	Wall Finish Material and Application	Ceiling Finish Material and Application
Kitchen		
Bath		
Other		

Additional information: _____

16. INTERIOR DOORS AND TRIM:
Doors: type _____; material _____; thickness _____
Door trim: type _____; material _____ Base: type _____; material _____; size _____
Finish: doors _____; trim _____
Other trim *(item, type and location)* _____
Additional information: _____

17. WINDOWS:
Windows: type _____; make _____; material _____; sash thickness _____
Glass: grade _____; ☐ sash weights; ☐ balances, type _____; head flashing _____
Trim: type _____; material _____ Paint _____; number coats _____
Weatherstripping: type _____; material _____ Storm sash, number _____
Screens: ☐ full; ☐ half; type _____; number _____; screen cloth material _____
Basement windows: type _____; material _____; screens, number _____; Storm sash, number _____
Special windows _____
Additional information: _____

18. ENTRANCES AND EXTERIOR DETAIL:
Main entrance door: material _____; width _____; thickness ____". Frame: material _____, thickness ____"
Other entrance doors: material _____; width _____; thickness ____". Frame: material _____; thickness ____"
Head flashing _____ Weatherstripping: type _____; saddles _____
Screen doors: thickness ____"; number _____; screen cloth material _____ Storm doors: thickness ____"; number _____
Combination storm and screen doors: thickness ____"; number ____; screen cloth material _____
Shutters: ☐ hinged; ☐ fixed. Railings _____, Attic louvers _____
Exterior millwork: grade and species _____ Paint _____; number coats _____
Additional information: _____

19. CABINETS AND INTERIOR DETAIL:
Kitchen cabinets, wall units: material _____; lineal feet of shelves ____; shelf width _____
Base units: material _____; counter top _____; edging _____
Back and end splash _____ Finish of cabinets _____; number coats _____
Medicine cabinets: make _____; model _____
Other cabinets and built-in furniture _____
Additional information: _____

20. STAIRS:

Stair	Treads		Risers		Stringer		Handrail		Balusters	
	Material	Thickness	Material	Thickness	Material	Size	Material	Size	Material	Size
Basement										
Main										
Attic										

Disappearing: make and model number _____
Additional information: _____

21. SPECIAL FLOORS AND WAINSCOT:

	Location	Material, Color, Border, Size, Gage, Etc.	Threshold Material	Wall Base Material	Underfloor Material
Floors	Kitchen				
	Other				

	Location	Material, Color, Border, Cap, Size, Gage, Etc.	Height	Height Over Tub	Height in Showers (From Floor)
Wainscot	Bath				

Bathroom accessories: ☐ Recessed; material _____; number _____; ☐ Attached; material _____; number _____
Additional information: _____

22. PLUMBING:

Fixture	Number	Location	Make	Mfr's Fixture Identification No.	Size	Color
Sink						
Lavatory						
Water closet						
Bathtub						
Shower over tub△						
Stall shower△						
Laundry trays						

△☐ Curtain rod △☐ Door ☐ Shower pan: material _____
Water supply: ☐ public; ☐ community system; ☐ individual (private) system.★
Sewage disposal: ☐ public; ☐ community system; ☐ individual (private) system.★
★*Show and describe individual system in complete detail in separate drawings and specifications according to requirements.*
House drain (inside): ☐ cast iron; ☐ tile; ☐ other _____ House sewer (outside): ☐ cast iron; ☐ tile; ☐ other _____
Water piping: ☐ galvanized steel; ☐ copper tubing; ☐ other _____ Sill cocks, number _____
Domestic water heater: type _____; make and model _____; heating capacity _____ gph. 100° rise. Storage tank: material _____; capacity _____ gallons.
Gas service: ☐ utility company; ☐ liq. pet. gas; ☐ other _____ Gas piping: ☐ cooking; ☐ house heating.
Footing drains connected to: ☐ storm sewer; ☐ sanitary sewer; ☐ dry well. Sump pump; make and model _____; capacity _____; discharges into _____

23. HEATING:
☐ Hot water. ☐ Steam. ☐ Vapor. ☐ One-pipe system. ☐ Two-pipe system.
☐ Radiators. ☐ Convectors. ☐ Baseboard radiation. Make and model _____
Radiant panel: ☐ floor, ☐ wall; ☐ ceiling. Panel coil: material _____
☐ Circulator. ☐ Return pump. Make and model _____; capacity _____ gpm.
Boiler: make and model _____ Output _____ Btuh.; net rating _____ Btuh.
Additional information: _____
Warm air: ☐ Gravity. ☐ Forced. Type of system _____
Duct material: supply _____; return _____ Insulation _____, thickness _____ ☐ Outside air intake.
Furnace: make and model _____ Input _____ Btuh.; output _____ Btuh.
Additional information: _____
☐ Space heater; ☐ floor furnace; ☐ wall heater. Input _____ Btuh.; output _____ Btuh.; number units _____
Make, model _____ Additional information: _____
Controls: make and types _____
Additional information: _____
Fuel: ☐ Coal; ☐ oil; ☐ gas; ☐ liq. pet. gas; ☐ electric; ☐ other _____; storage capacity _____
Additional information: _____
Firing equipment furnished separately: ☐ Gas burner, conversion type. ☐ Stoker: hopper feed ☐; bin feed ☐
Oil burner: ☐ pressure atomizing; ☐ vaporizing _____
Make and model _____ Control _____
Additional information: _____
Electric heating system: type _____ Input _____ watts; @ _____ volts; output _____ Btuh.
Additional information: _____
Ventilating equipment: attic fan, make and model _____; capacity _____ cfm.
kitchen exhaust fan, make and model _____
Other heating, ventilating, or cooling equipment _____

24. ELECTRIC WIRING:
Service: ☐ overhead; ☐ underground. Panel: ☐ fuse box; ☐ circuit-breaker; make _____ AMP's _____ No. circuits _____
Wiring: ☐ conduit; ☐ armored cable; ☐ nonmetallic cable; ☐ knob and tube; ☐ other _____
Special outlets: ☐ range; ☐ water heater; ☐ other _____
☐ Doorbell. ☐ Chimes. Push-button locations _____ Additional information: _____

25. LIGHTING FIXTURES:
Total number of fixtures _____ Total allowance for fixtures, typical installation, $ _____
Nontypical installation _____
Additional information: _____

DESCRIPTION OF MATERIALS

26. INSULATION:

Location	Thickness	Material, Type, and Method of Installation	Vapor Barrier
Roof			
Ceiling			
Wall			
Floor			

27. MISCELLANEOUS: *(Describe any main dwelling materials, equipment, or construction items not shown elsewhere; or use to provide additional information where the space provided was inadequate. Always reference by item number to correspond to numbering used on this form.)*

HARDWARE: *(make, material, and finish.)*

SPECIAL EQUIPMENT: *(State material or make, model and quantity. Include only equipment and appliances which are acceptable by local law, custom and applicable FHA standards. Do not include items which, by established custom, are supplied by occupant and removed when he vacates premises or chattles prohibited by law from becoming realty.)*

PORCHES:

TERRACES:

GARAGES:

WALKS AND DRIVEWAYS:

Driveway: width _____ ; base material _____ ; thickness _____ "; surfacing material _____ ; thickness _____ "
Front walk: width _____ ; material _____ ; thickness _____ ". Service walk: width _____ ; material _____ ; thickness _____ "
Steps: material _____ ; treads _____ "; risers _____ ". Cheek walls _____

OTHER ONSITE IMPROVEMENTS:

(Specify all exterior onsite improvements not described elsewhere, including items such as unusual grading, drainage structures, retaining walls, fences, railings, and accessory structures.)

LANDSCAPING, PLANTING, AND FINISH GRADING:

Topsoil _____" thick: ☐ front yard; ☐ side yards; ☐ rear yard to _____ feet behind main building.
Lawns *(seeded, sodded, or sprigged)*: ☐ front yard _____ ; ☐ side yards _____ ; ☐ rear yard _____
Planting: ☐ as specified and shown on drawings; ☐ as follows:

_____ Shade trees, deciduous, _____" caliper.
_____ Low flowering trees, deciduous, _____' to _____'
_____ High-growing shrubs, deciduous, _____' to _____'
_____ Medium-growing shrubs, deciduous, _____' to _____'
_____ Low-growing shrubs, deciduous, _____' to _____'
_____ Evergreen trees. _____' to _____', B & B.
_____ Evergreen shrubs. _____' to _____', B & B.
_____ Vines, 2-year _____

IDENTIFICATION.—This exhibit shall be identified by the signature of the builder, or sponsor, and/or the proposed mortgagor if the latter is known at the time of application.

Date _____ Signature _____

Signature _____

FHA Form 2005
VA Form 26–1852

GPO : 1976 O - 219-089

HANDOUT #24

Sample Materials Estimate Form

Mr./Ms.:_____

Job: _____

Address:_____

FOUNDATION ACCESSORIES:	
Ea. Bags Mortor Mix___sq. ft. x 7=____x .007 =	Ea.
Ea.____" Anchor Bolts w/nuts	Ea.
Ea. Foundation Vents Model #_____	Ea.
Roll____" Termite Shield	Rl.
Ea. Boxes Brick Ties_____ga.	Bx.
LINTELS:	
Ea._____Angle Iron	Ea.
Ea._____Angle Iron	Ea.
Ea._____Angle Iron	Ea.
Ea._____Angle Iron	Ea.
FIREPLACE ACCESSORIES:	
Ea. Damper_____" Stock #_____	Ea.
Ea.____" x____" x____" Steel Angles Stock #____	Ea.
Ea.____" x____" Ash Dump Stock #____	Ea.
Ea.____" x____" T-Irons	Ea.
Ea.____" x____" Clean out-door	Ea.
Ea. Fire Brick	Ea.
Pcs.____" x____" Flue Liner	Pc.
Ea. Thimble	Ea.

Mr./Ms.: _____

Job: _____

Address: _____

FLOOR SYSTEM: is on _____ type foundation	
( ) with ( ) without 2 x 6 treated mud-sills.	
Girders & sills to be 2 x _____ with 2 x _____ joists @	
_____" o.c. Bridging to be ( ) "x" or ( ) solid type.	
Sub-flooring is _____.	
Framing to be ( ) SYP or ( ) West Coast	
Lft. 2 x 6 Mud Sill x 1 BF/LF =	Bf M
Pcs. 2 x ____ x ____ Sills = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Total _____Lft. x _____Bf/Lf	Bf M
Pcs. 2 x ____ x ____ Girders = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Total _____Lft. x _____Bf/Lf	Bf M
Lft. 2 x 4 Ledger Material x .67 Bf/Lf =	Bf M
Pcs. 2 x ____ x ____ Joists = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Pcs. 2 x ____ x ____ " = _____Lft.	
Total _____Lft. x _____BF/LF	Bf M
Lft. 1 x 4 Bridging x .333 Bf/Lf =	Bf M
Lft. 2 x ____ Solid Blocking x ____ Bf/Lf =	Bf M
Pcs. _____" x 4'0" x 8'0" _____ Plywood Sub-floor	Pc.
Lft. 1 x _____ Diagonal Sub-floor x _____Bf/Lf =	Bf M
Rolls #15 Felt (Optional)	Rl.

Mr./Ms.: _____

Job: _____

Address: _____

WALL SYSTEM:		
_____ Lft. Ext., _____ Lft. Ext. over-Ht. _____ Lft. Int.		
Lft. 2 x 4 Treated Pine Sole Plates x .67 =	BF	M
(At garages and slab areas etc.)		
Lft. 2 x 4 Sole, Top, and Double Plates (FS) x .67 =	BF	M
Lft. 2 x 4 Purlin Material (Optional) (FS) x .67 =	BF	M
Ea. 2 x 4 Lodge Pole Pine Studs		Ea.
Ea. 2 x 4 x 10'0" Studs (over-Ht.) (FS) x .67 =	BF	M
Lft. 2 x ___ x 16'0" Special Width Studs (FS) x _____ =	BF	M
Lft. 2 x 4 Furr. Down Material (FS) x .67 =	BF	M
(" " c _____, _____, _____, _____)		
HEADERS:		
Pcs. 2-2 x ___ x ___ = ___Lft. x ___BF/LF	BF	M
Pcs. 2-2 x ___ x ___ = ___Lft. x ___BF/LF	BF	M
Pcs. 2-2 x ___ x ___ = ___Lft. x ___BF/LF	BF	M
Pcs. 2-2 x ___ x ___ = ___Lft. x ___BF/LF	BF	M
Pcs. ½" x 4' x 8' C.D. Plywood (Flitch Plates for Hdrs.)(Cnr.B)		Pc
Pcs. ½" x 4' x 8' Insulated Impregnated Sheathing Bd.		Pc
Pcs. ½" x 4' x 9' Insulated Impregnated Sheathing Bd.		Pc
Ea. Rolls #15 Felt (Optional)		Rl
Ea. Rolls 6' Batt Insulation (Clg)		Rl
Ea. Rolls 3½" Batt Insulation (Walls)		Rl
Ea. Rolls 2¼" Batt Insulation (Floor)		Rl
Pcs. ___" x 4' x 8' ___ siding ___ design		Pc
Pcs. ___" x 4' x 9' ___ siding ___ design		Pc
Lft. 1 x ___ _____ siding ___ design x _____ BF/LF	BF	M
Bdls. ___" x ___" siding		Bdl
Legend: T.P. = Treated Pine P.S. = Pine Studs		
F.S. = Fir, Spruce Y.P. = Yellow Pine		
C.B.D.F. = C & Btr. Douglas Fir C.S. = Const./Std.		
R.C.H. = Redwood Construction Heart S4S Ut. = Utility		

Sub-Total _____

HANDOUT #24, p.4

Mr./Ms.: _____

Job: _____

Address: _____

ROOF SYSTEM:		
Lft. 2 x 4 Deadwood & Gar. Dr. .67 Bf/Lf		Bf M
Lft. 2 x 6 Deadwood & Gar. Dr. 1 Bf/Lf		Bf M
Pcs. 2 x 4 x 12'0" Wind Bracing (walls, gables, etc.) Lf		Bf M
CEILING JOISTS:		
Pcs. 2 x ___ x ___ = ___ Lft. x ___ Bf/Lf =		Bf M
Pcs. 2 x ___ x ___ = ___ Lft. x ___ Bf/Lf =		Bf M
Pcs. 2 x ___ x ___ = ___ Lft. x ___ Bf/Lf =		Bf M
RAFTERS:		
Pcs. 2 x ___ x ___ = ___ Lft. x ___ Bf/Lf =		Bf M
Pcs. 2 x ___ x ___ = ___ Lft. x ___ Bf/Lf =		Bf M
Lft. 1 x 6 Ridge & Wind Beam x .5 Bf/Lf =		Bf M
Lft. 2 x 4 Ribbon & Fascia Back-Up (FS) x .67 Bf/Lf =		Bf M
Lft. 2 x 4 Outlookers & Blocking (FS) x .67 Bf/Lf =		Bf M
Ea. Trusses ___ Bot. Chord, ___ Pitch, w/___ O.H.		Ea.
Ea. Trusses ___ Bot. Chord, ___ Pitch, w/___ O.H.		Ea
Ea. Gables ___ Bot. Chord, ___ Pitch, w/___ O.H.		Ea
Set ___ Pitch valley trusses (for ___ span)		Set
Lft. 1 x 4 Truss Ties x .333 Bf/Lf		Bf M
Pcs. ___" x 4' x 8' ___ Plywood (Roof Sheathing & Attic if applicable)		Pc
Rolls #15 Felt		Rl
Sqs. # ___ Asphalt Shingles		Sq
Lft. Metal Vent-O-Ridge		Lf
Ea. Connectors		Ea
Ea. End Caps		Ea
Ea. Metal Roof Vents		Ea
Ea. ___ Base ___ Pitch Triangle Wood Louver		Ea

Mr./Ms.: _____

Job: _____

Address: _____

WINDOWS & EXTERIOR DOORS (w/Precut Int. Trim) (___Yes, ___No)	
Mfg'd by _____, insulated glass _____,	
screens included _____, storm windows _____,	
jamb extensions _____	
Ea. ___ x ___ Style _____ L.A. @ ___ + S.W.	Ea
Ea. ___ x _____ @ ___ + _____	Ea
Ea. ___ x _____ @ ___ + _____	Ea
Ea. ___ x ___ _____ ___ @ ___ + ___	Ea
Ea. ___ x ___ _____ ___ @ ___ + ___	Ea
Ea. 3^0 x 6^8 x 1 3/4" ___ hand, prehung door unit ___ style	
w/sill, ___ finish, ___ core ___ mat'l.	Ea
Ea. 2^8 x 6^8 x 1 3/4" ___ hand, prehung door unit ___ style	
w/sill, ___ finish, ___ core ___ mat'l	Ea
Ea. ___ x 6^8 x 1 3/4" hand, prehung door unit ___ style	
___ finish, ___ core ___ mat'l (no sill)	Ea
Ea. 6^0 x 6^8 x 1 3/4" Double Prehung Door Unit	
___ style ___ finish ___ core ___ mat'l	Ea
Ea. 3^0 x 6^8 x ___ " Screen Door	Ea
Ea. 2^8 x 6^8 x ___ " Screen Door	Ea
Ea. ___ x ___ Garage Door Jambs	Ea
Ea. ___/___ x 6^8 Patio Door., Screen and Hardware	Ea
Ea. ___/___ x 6^8 Patio Door., Screen and Hardware	Ea
Ea. ___/___ x 6^8 Patio Door Frame	Ea
Ea. ___/___ x 6^8 Patio Door Frame	Ea
L.A. = Lt. Arrng. S.W. = Storm Win.	

Mr./Ms.: _____

Job: _____

Address: _____

EXTERIOR TRIM:	
Lft. 1 x 12 (Ax Handle Return)	Lf
Lft. _____" Bed Mould (@ eaves) WP74	Lf
Lft. 1 x _____ Fascia Bd.	Lf
Lft. 1 x _____ Frieze Bd.	Lf
Lft. 1 x _____ Shingle & Rake Mould	Lf
Lft. 1 x 5 Soffit above wdws. @ B.V. & Btm Bm Trim	Lf
Pcs. _____ x 4' x 8' _____ Plywood (Soffit & Decor Mat'l)	Pc
Lft. _____" Maywood "c" Mould (Decor Trim)	Lf
Lft. 2" Brick Mould (@special wdws & decor)	Lf
Lft. _____ Fake Sill (@ Decor)	Lf
Lft. _____ x _____ Gable Mould	Lf
SIDING ACCESSORIES	
Pcs. _____ x _____ outside corners	Pc
Pcs. _____ x _____ inside corners	Pc
Pcs. 1 x _____ Batts	Pc
Ea. Metal Corners	Ea
Lft. _____ x _____ Plant-ons over siding	Lf
Lft. 1 x _____ Dentil Mould	Lf
Lft. 1 1/16" x 1 3/4" Wood Drip Cap #8926	Lf
Pcs. 3" x 8'0" Metal Screen Vents	Pc
Pcs. _____" x _____" Metal Screen Vents	Pc
Pr. _____" x _____" Shutters	Pr
Pr. _____" x _____" Shutters	Pr
Ea. _____" x _____" Cupola	Ea
Ea. Scrolled Wood Brackets	Ea
Ea. _____ x _____ Wood Deck (Treated Mat'l) (See opp. pg.)	Ea

Mr./Ms.: _____

Job: _____

Address: _____

INTERIOR TRIM:		
Lft. _____ " Base	Stock # _____	Ea
Lft. 1/2 " x 3/4 " Shoe	Stock #WP 126	Ea
Lft. _____ " Mullion		Lf
Lft. _____ " Casing Type	Stock # _____	Lf
Lft. _____ " Apron	Stock # _____	Lf
Lft. _____ " Window Stop	Stock # _____	Lf
Lft. _____ " Stool		Lf
Lft. _____ " Chair Rail Mould	Stock # _____	Lf
Lft. _____ " Bed or Crown Mould	Stock # _____	Lf
Pcs. _____ " x 4' x 8' Paneling	Stock # _____	Pc
Lft. 12" Shelving Grade Bd. (cleating included)	Stock # _____	3 KP Lf
Lft. 1 3/8" Closet Rod Dowel		Lf
Interior Door Units: _____ Stype & _____ Finish		
_____ " Jambs ( ) FJ or ( ) Clear, _____ Type Csg.		
Ea. _____/_____ x 6^8 x 1 3/8" _____ Ea. RH, _____ Ea. LH		Ea
Ea. _____/_____ x 6^8 x 1 3/8" _____ Ea. RH, _____ Ea. LH		Ea
Ea. _____/_____ x 6^8 x 1 3/8" _____ Ea. RH, _____ Ea. LH		Ea
Ea. _____/_____ x 6^8 x 1 3/8" _____ Ea. RH, _____ Ea. LH		Ea
Ea. _____/_____ x 6^8 x 1 3/8" Bi-Fold, Swinging Dbl. Hinge, Sliding, Style		Ea
Ea. _____/_____ x 6^8 x 1 3/8" Bi-Fold, Swinging Dbl. Hinge, Sliding		Ea
Ea. _____/_____ x 6^8 x 1 3/8" Bi-Fold, Swinging Dbl. Hinge, Sliding		Ea
Ea. _____/_____ x 6^8 Cased Opening ( ) F.J. ( ) Clear		Ea
Ea. _____/_____ x 6^8 Cased Opening ( ) F.J. ( ) Clear		Ea
Rolls #15 Felt		Rl
Ea. Sets Weatherstripping		Ea
Pcs. _____ " x 4' x 8' _____ Plywood underlayment		Pc
Pcs. _____ " x 4' x 12' Drywall CL6.; Walls		
Sq. Ft. _____ Finish Flooring (Flr. Area _____ x 1.3)		Sf

Mr./Ms.: _____

Job: _____

Address: _____

STAIR PARTS:	
Lft. _____ " x _____ " Scotia Mould	Lf
Lft. 1 x _____ Skirtboard	Lf
Pcs. _____ " x _____ _____ Treads	Pc
Pcs. 1 x _____ _____ Risers	Pc
Ea. _____ x _____ Balusters Stock # _____	Ea
Ea. _____ x _____ Balusters Stock # _____	Ea
Ea. _____ x _____ Balusters Stock # _____	Ea
Ea. _____ Rossettes Stock # _____	Ea
Ea. _____ x _____ Newels Stock # _____	Ea
Lft. _____ Handrail & Hardware	Lf
Ea. 2 x _____ Stringer Material	Ea
Ea. 2 x _____ x _____ Pine Treads (Basement)	Ea
Ea. 2 x 4 x 16'0" Handrail (Basement)	Ea
Ea. _____ hand volute Stock # _____	Ea
Ea. _____ " x _____ " Disappearing Stairway, Stock # _____	Ea
Ea. Prefabricated Stairways: (See Attached Sheet for Details)	Ea
_____ Type Treads, _____ Type Risers	
_____ " Rise, _____ " Run, _____ Width	
(Out to out of stringers) Allow ½" fitting space inside	
finished opening.	

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Mr./Ms.: _____

Job: _____

Address: _____

SUMMARY:		
Finish Hardware Allowance		
Rough Hardware Allowance		
Total Allowance		
Kitchen Cabinets & Tops, Allowance		
SUMMARY:		
Sht. 1	Foundation	
Sht. 2	Floor System	
Sht. 3	Wall System	
Sht. 4	Roof System	
Sht. 5	Windows & Exterior Doors	
Sht. 6	Exterior Trim	
Sht. 7	Interior Trim	
Sht. 8	Stair Parts	
Sht. 9	Hardware & Cabinets	
	_____% contingency	_____
	Sale Price Plus Tax (effective 30 days)	$ _____

HANDOUT #25

CUMULATIVE JOB COST
RECORD SHEET

Date	Item	Labor	Materials	Fees	Equip. Rental

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: GETTING READY TO BEGIN

TASK: (No. 25) LIST RESPONSIBILITIES FOR SUBCONTRACTING

COMPETENCY: UNDERSTAND THE LEGALITIES AND TECHNICALITIES OF SUBCONTRACTING WORK

CRITERION MEASURE:
USES PERSONAL CONTACTS TO FIND GOOD SUBCONTRACTORS
UNDERSTANDS FINANCIAL RESPONSIBILITIES TO SUBCONTRACTORS
UNDERSTANDS LEGAL RESPONSIBILITIES TO SUBCONTRACTORS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Using personal contacts to find subcontractors	I. Types of personal contacts A. Friends B. Materials suppliers C. Yellow pages (local establishment) D. Other subcontractors	I. Using all possible resources to find good, responsible subcontractors
II. Negotiate contracts with subcontractors	II. Financial responsibilities A. Agreement on cost of job B. Agreement on terms of payment for job 1. Labor 2. Materials 3. Equipment use C. Agreement on date(s) of payment D. Obtain lien waiver upon payment	
III. Legal considerations	III. Legal considerations A. Workman's compensation insurance 1. Held by subcontractor (or) 2. Held by you B. Builders' risk policy C. Other insurance requirements	

REFERENCES (see Bibliography for complete information)

Building Your Own Home

From the Ground Up
See previous description.

Building for Self-Sufficiency includes an excellent chapter entitled "Tools."

CONSTRUCTION

CONSTRUCTION

The intent of the construction segments (3) is to provide guidelines to assist the instructor in providing information about energy saving choices during the construction process. The segments will follow in a chronological order simulating the actual construction of a house. The content of class discussions will reflect the types of problems usually encountered and should help generate solutions. The topic outline is intended as a guide to sequence. Ideas and questions introduced in each section along with the referenced texts, local information and class needs should provide the basis for these three sessions. Renovation techniques should be presented along with new construction topics.

A. Foundations/Beginning

Footings

This is the first actual construction step. Remember to emphasize that accuracy is essential on layout of batterboards and line is critical. Digging the foundations will probably need to be subcontracted. Weather conditions are not predictable but proper conditions are necessary for concrete to set-up and cure.

Foundation Walls

Various types of materials to be used for foundation walls should be discussed (concrete, brick and block, stone, wood, etc.). Points such as waterproofing, foundation drains, foundation vents, reinforcing, types of insulation, and vapor barriers should be discussed.

In terms of energy, consider insulation methods which are applicable with each type of foundation system to enable the builder to achieve minimum R-19 over crawl space or outside air and ± R-10 over earth in case of slab. Discuss the potential for thermal mass storage in slab construction and the site conditions which will work with slab construction.

Insect Control

Many loan institutions will require termite poison (as will most insurance companies). The two basic types of termite protection should be discussed: soil poisoning and termite shields. Soil poisoning should be done by an expert who knows how to handle the chemicals. A termite shield keeps the insects from crawling up the foundation and into woodwork. It also acts as a vapor barrier to keep the sill plate from getting wet and rotting.

B. Drying In

This section deals with the skin and bones of the house (the framing of exterior walls and roof). Hammering and nailing is the part of the construction that the student will most likely choose to do.

Construction of floors will be partially dependent on the type of finish flooring to be used. Floor joint span data should be referred to. All wood in contact with masonry should be pressure treated. Sills should be anchored to foundation walls.

Various construction techniques for walls are important to discuss. They will affect stability and ease of construction.

Various insulation systems for floor, wall and roof construction should be discussed. The approach a student takes to insulating the house could well determine the spacing and thickness of the construction. Special consideration should be given to insulation of corners and headers. These spaces are often left out.

Roofs and ceiling joists should be sized with rafter span, data tables in North Carolina Code or elsewhere, the type of roof desired and presence (or absence) of an attic storage space. Trusses should be discussed.

Determinations for window and door placement will affect the framing, and these should be considered. It would be well to re-emphasize south glass orientation at this point. Discussion of headers for long spaces, including flitch plates, will help to get the glass in the correct place.

Sheathing must be applied to the framing before an exterior wall covering is applied. The class may discuss single wall covering (sheathing with a "finish on one side"so that no other exterior finish is needed). Stress, however, that the "double skinned" house will be more weatherproof and cost slightly more. Various types of insulating sheathing can now be purchased and will increase the R-value of the walls. Particularly in areas where builders are resistant to 2 x 6 wall framing, students can consider insulation sheathing as a way to get their walls up to proper insulation levels.

Careful note should be taken of manufacturers' recommendations for dealing with vapor barriers when using insulating sheathing. The foam boards are generally vapor barriers, creating a potential source of condensation within the wall. A stapled polyethane vapor barrier or foil backed sheetrock can preclude moisture from getting into the walls. Some manufacturers recommend an air space be left between the top plate and the sheathing.

Roofing materials should be discussed with such factors as cost, ease of installation, longevity under consideration.

Consider steps to minimize infiltration during dry-in, such as caulking under plates, preinsulating corners, and headers as frame goes together.

Emphasize roof and attic space ventilation as an important energy consideration. The best non-mechanical venting is by continuous soffit and ridge venting. Gable vents can be substituted for ridge vents but they are not as effective. Turbine vents are also an effective attic space ventilation system. Discuss thermostatically controlled fans.

Emphasize also the requirement for venting all rafter spaces between the top of the insulation and the underside of the sheathing.

Discuss various choices for window types. Wood windows, while generally thought to be aesthetically preferable and more energy efficient than aluminum, are also much more expensive. Consider "thermal break" aluminum

windows as a compromise. Special care should be taken in installation to caulk, weather strip, and insulate around windows to stop infiltration.

Exterior door choices are solid core wood and metal insulated. The metal doors often are available with special magnetic weather stripping and coupled with the internal insulation make an excellent energy saver.

Sliding glass doors used properly to admit south light into the house represent the least expensive way to gain large sections of glass and ventilation for the house. They are available in aluminum, "thermal break" aluminum, and wood and have the same pluses and minuses as metal and aluminum windows.

C. Installing Environmental Systems

Almost all the systems in this section may require some sort of inspection (unless your county is without building codes). Attention must be given to fitting the right type and size of system to the individual house. Study existing installations and note energy conserving applications and appliances. Consider the factors of how systems will be routed through the house in relation to each other. In practice, the heating and air conditioning contractor generally will size the duct system and furnace for the house. If the student has done a careful heat loss calculation it should be made available as contractors generally use a form similar to the short one included in the course. Duct design should be based on "1/10 static pressure" to hold down duct noise in the system. All ducts in unheated space should be insulated. Joints in ductwork should be taped. Again, discuss the value of placing return air grille high in the house to enable the system to recirculate warm air into the house. Make certain heating systems are slightly under instead of oversized. Oversizing a furnace will result in cycling--cutting on and off in rapid succession, making operation more expensive.

The electrical wiring of the house is a relatively complicated task and probably should be subcontracted to a licensed electrical contractor. However, the code will allow owner-builders to do their own wiring and reference books will be helpful as basic texts for wiring. Service for the house must be considered early in terms of required capacity of the system and whether it will connect to the house overhead or underground. Both approaches will probably involve loss of trees; care in negotiating rights of way is advisable. House wiring is generally broken down into two parts: rough wiring which is done prior to insulation, or installing interior surfaces and finish wiring which involves installing lighting fixtures, outlets, etc.

In terms of energy, discuss careful insulation around and in back of electrical outlet boxes on outside walls. Aluminum wiring should be discussed. Most codes do not allow it and it should be discouraged as a fire hazard. The cost of wiring can be minimized by careful location of the panel box in conjunction with the meter, and the large electrical appliances such as stove, dryer, furnace, etc. By keeping these items close together, the individual can lower cost of electrical materials.

Plumbing is another area where expertise is required. Location of water main (or well) and sewer (or septic tank) should be a part of the early planning of the house. Local utilities or health department should be consulted early for their requirements. Discuss the highlights of the energy ideas presented earlier, including the following item. Backing up toilet and kitchen areas will save money in plumbing. Also consider the location of the hot water heater relative to the tub and lavatories. The hot water lines between the heater and the taps should be insulated. Hot water heater timers and insulation blankets are definitely worthwhile and should be re-emphasized. Also "demand" hot water heaters should be mentioned again.

Solar water heating systems should be discussed at this point and, if possible, the class should observe systems in operation. Such systems will lower costs in the long run and make the individual home owner a little more self-sufficient.

Students may have their own ideas about the type of systems with which they intend to power or heat their homes. Encourage them to discuss details of actual installation of these systems.

Insulation is an extremely important factor in the comfort of an individual's home. Students can install it themselves (except foam systems), but stress the need to dress properly and wear a mask. Insulation, particularly fiberglass, can be extremely irritating to the lungs and skin. Make sure the student is aware of all the locations insulation should be installed to make the house free from energy leaks (walls, floors, ceilings, around doors and windows, basements spaces). Various types of insulation should be individually discussed in terms of their thermal efficiency cost, ease of installation, and fire potential. It would be instructive to have local material prices available and convert them into a cost per "R" factor similar to the wall system analysis in Your Next Home. Students should be encouraged to ask opinions from former clients, or the local insulation inspector before signing a contract with an insulation contractor.

Once again, emphasize the need to control infiltration into the house and the materials available to do this. The individual should check with the local electric utility to determine their requirements for "energy efficient" electric rates. Some of these requirements may not recognize solar passive design in that they may limit the amount of glass area and not recognize the potential solar gain. Problems of this sort should be dealt with before beginning construction.

D. Finish Work

For this section it is wise for the student to refer to a good book on cabinetry and woodworking. Most finish work requires a number of tools, some skill and a lot of work. Careful planning and scheduling may help students avoid doing finish work long after they move in.

If the student is having someone hang sheetrock walls, it is important to find out to what extent the subcontractor will finish the walls (spackling, sanding, priming, painting, etc.). Any type of subcontractor for walls, electrical, plumbing, etc. should specify the type and amount of work and materials that are included in the price an individual will pay. If the subcontractor does not do this, then it should be requested.

Finish work normally includes floors, walls, ceilings, painting trim work, and such hardware items as door knobs, drawer and cabinet pulls. In doing finish trim around doors and windows remember to fill cracks with insulation before covering. This will do a lot to slow down infiltration heat loss. Remember to install caulking around the outside of the trim and to weatherstrip. Good permanent weatherstripping seals made of metal and/or rubber primarily will do a lot to stop infiltration and will be much easier to install them while building rather than to try to retrofit.

From each subcontractor who does work that must be inspected, the builder should receive a certificate of inspection. It is important to stay up to date on inspections, and if the student has done the proper preliminary work, this should be no problem.

Generally, the final inspection the student must arrange for is a certificate of occupancy. This will give the individual a legal right to actually live in the house. It generally is not necessary to have everything finished if the house is to be occupied by the builder. A lot of the trim work is not necessary to dwell in a house. It is essential, though, that the house be safe: no loose wiring, nothing hanging that could fall, no holes in the floor, etc. Before making final payment to any subcontractor it is traditional to make a thorough inspection of their work and should things remain undone compile a "punch list" of items to be completed. In dealing with subcontractors the student is advised to always withhold from payment enough money to hire another contractor to complete the work not completed should the original contractor default.

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: CONSTRUCTION

TASK: (No. 26) LIST PLACEMENT AND SIZE OF DOORS, WINDOWS AND SKYLIGHTS

COMPETENCY: RECOGNIZE NEED TO DETERMINE SIZE, PLACEMENT AND TYPE OF DOORS, WINDOWS AND SKYLIGHTS BEFORE FRAMING HOUSE

CRITERION MEASURE:
DETERMINES ROUGH FRAMING FOR DOORS, WINDOWS AND SKYLIGHTS
DETERMINES BEST PLACEMENT OF WINDOWS AND DOORS FOR SOLAR GAIN (PASSIVE SOLAR HEATING) AND VENTILATION
DETERMINES BEST PLACEMENT AND MEANS FOR INSTALLING SKYLIGHTS

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Doors	I. Considerations for doors A. Placement for optimum traffic flow B. Making your own doors C. Size of doors (interior and exterior)	I. Understand where doors should go
II. Windows	II. Window considerations A. Placement for ventilation (refer to charts for summer wind direction) B. Placement for optimum solar gain in winter C. Window shades or overhang to protect against summer sun D. Drapes or insulating panels to prevent nighttime or winter heat losses E. Recycling windows F. Types of glass 1. Single glazed 2. Thermopane (double glazed) 3. Triple glazed	II. Understand usefulness of windows and types of windows appropriate for different uses

OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
III. Skylights	III. Considerations for skylights A. Material 1. Glass a) Single glazed b) Thermopane 2. Plexiglass a) Opaque b) Transparent B. Use 1. Lighting 2. Heating 3. View C. Installing 1. Make your own 2. Prefabricated D. Sealing E. Insulating	III. Know the usefulness of a skylight and advantages and disadvantages of having them

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ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: CONSTRUCTION

TASK: (No. 27) LIST TYPES AND AMOUNTS OF INSULATING MATERIALS NEEDED FOR DWELLING

COMPETENCY: ABILITY TO EFFECTIVELY USE INSULATION TO ITS BEST ADVANTAGE IN THE SURROUNDING ENVIRONMENT

CRITERION MEASURE:
RECOGNIZES DIFFERENT TYPES OF INSULATION
UNDERSTANDS BEST LOCATION FOR DIFFERENT TYPES OF INSULATION
KNOWS AMOUNT OF INSULATION RECOMMENDED FOR LOCATION
ACKNOWLEDGES SAFETY PRACTICES WHEN INSTALLING INSULATION
RECOGNIZES USE OF VAPOR BARRIER

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Types of insulation	I. Insulation characteristics A. Batts (fiberglass) B. Blankets (fiberglass) C. Loose 1. Cellulose 2. Fiberglass 3. Mineral wool D. Rigid board E. Foamed in place (urea-formaldehyde)	I. Learn the best types of insulation for house needs
II. Where to insulate	II. Places to insulate A. Walls B. Floor C. Ceiling D. Crawlspace E. Pipes F. Ducts	II. Know what sites should be insulated for maximum effectiveness
III. How much insulation	III. Quantity A. Area to be covered B. Thickness of insulation (R-value)	
IV. Other considerations	IV. Other needs A. Vapor barrier B. Safety while installing	

ANALYSIS

CURRICULUM: OWNER-BUILDERS

SUBJECT AREA: CONSTRUCTION

TASK: (No. 28) INSTALL WEATHERSTRIPPING AND CAULKING

COMPETENCY: USE CAULKING AND WEATHERSTRIPPING TO MAKE HOUSE MORE ENERGY EFFICIENT

CRITERION MEASURE:
KNOWS WHERE TO WEATHERSTRIP
RECOGNIZES TYPES OF WEATHERSTRIPPING
KNOWS WHERE TO CAULK AND PROPER PROCEDURE
RECOGNIZES TYPES OF CAULKING

OUTLINE OF INSTRUCTIONAL CONTENT

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
I. Know where to install different types of weatherstripping	I. Where to weatherstrip and types A. Windows 1. Rolled vinyl 2. Thin spring metal 3. Foam rubber with adhesive backing B. Doors 1. Adhesive backed foam 2. Foam rubber with wood backing 3. Rolled vinyl with aluminum channel 4. Spring metal 5. Sill seals a) Door shoes b) Sweeps c) Vinyl bulb threshold d) Interlocking metal channels e) Interlocking threshold	I. Recognizing where to seal properly to keep down energy leaks caused by air infiltration
II. Know different types of caulk and where to use it	II. Spaces to caulk A. Between tops of windows and siding B. Between door molding and siding	

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OUTLINE OF INSTRUCTIONAL CONTENT (CONTINUED)

SKILL/PROCESS	KNOWLEDGE/THEORY	VALUE/ATTITUDE CONCEPTS
	II. (Continued) C. At joints between window frames and siding D. At foundation sill E. At outside water faucets F. Where masonry and siding meet G. Between subfloor and bottom plate III. Types of caulking compounds with characteristics A. Oil or resin base 1. Readily available 2. Will bond most surfaces 3. Not very durable 4. Lowest cost B. Latex, butyl or polyvinyl based 1. Readily available 2. Bonds to most surfaces 3. More durable but more expensive C. Elastomeric 1. Most durable 2. Most expensive	

REFERENCES (see Bibliography for complete list)

Building Your Own Home is an excellent no-frills book which deals, step-by-step, with house construction. It can be used in conjunction with course information on energy to put together a logical approach to construction.

SUMMARY

SUMMARY

This is the summation of all material covered previously: a good time to review problem areas, make sure students are familiar with the technical jargon they need to know. Review calculations and any other areas that may be problems. Emphasize conservation of materials where possible and the use of energy-saving construction techniques and systems. The slide presentation may be reviewed.

By this time the students should have a grasp of some basic concepts of house-building:

- What is needed/desired in a house
- What materials will achieve the desired effect
- A feel for the portion of work that must be subcontracted out and the work that the student can do
- The financial and legal responsibilities of building
- A good understanding of energy concepts and systems that can be applied to owner-built energy efficient homes
- An ability to understand calculations concerning sizes of environmental systems needed and costs of materials and labor
- Understanding of the skills and tools involved if the student intends to do a lot of the work
- How to develop a bookkeeping system

and most importantly

- To understand the magnitude of the project and be able to cope with problems that occur.

Basic attitudes that are important to develop from this course are concepts such as doing one's own work whenever possible and putting the best possible quality into the work that is done. The individual is learning how to organize structural spaces into a responsive dwelling that meets the needs of the builder and is also a dwelling that is socially, ecologically, and structurally satisfying.